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ERRATA.

Page 310, line 9 from bottom, *p* has dropped out from *E. cyanocephala* (Lath.).

,, 327, top line heading table (Dr. Günther's paper on extinct Mascarene Lizards), *G. Newtonii* and *G. verus* should be transposed and correspond in position to those in table p. 326.

,, 348, lines 11, 12, & 13, O, O, O should be C, C, C, in agreement with the contraction for genus *Callichrous*.

THE JOURNAL

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THE LINNEAN SOCIETY.

On the Geographical Distribution of the Accipitres.

By R. Bowdler Sharpe, F.L.S., F.Z.S., &c.

[Read February 3, 1876.]

(Plates I.–IX.)

Part I. *The* VULTURIDÆ.

The following papers will form a supplement to the British-Museum 'Catalogue of Birds.' In the latter volume a classification of the Accipitres is unfolded; and I now propose to treat of the geographical distribution of the birds described in the first volume of that work; for until a classification has been determined upon, my experience tells me that it is impossible to treat of the distribution of the feathered tribes over the earth's surface. I am at the same time aware that several writers have called in question my arrangement of the birds of prey, notably that conscientious and indefatigable naturalist Mr. Robert Ridgway; but I have as yet found no reason to modify my conclusions in any serious degree; and I therefore feel pleased to have an opportunity of expounding my system of classification of the Accipitres, feeling, as I do, that the consideration of their geographical distribution will confirm the views expressed in the work above alluded to.

It is here necessary only to state that I divide the birds of prey into three distinct groups, which I consider to be of the rank of suborders. These are Hawks, Ospreys, and Owls. The second and the last have a remarkable osteological character in common in the long tibia, which is more than double the length of the tarsus; and they have at the same time the outer toe reversible. These

points seem to me to be of the first importance; and as further characters can be found for the separation of the Owls from the other birds of prey, it seems to me natural to consider the Ospreys as Accipitres with an owl-like structure and the habits of Fishing Eagles; and thus they would naturally occupy an intermediate position between the Owls and the great mass of the diurnal birds of prey.

The first of my suborders, the Falcones, is much the largest of the three, and may be divided into two primary groups—Vultures (Vulturidæ) and Hawks (Falconidæ). The former have never any *true* feathers on the crown of the head, this part being either quite bare or covered with silky down. In habits, the American Vultures so closely resemble those of the Old World, that I cannot bring myself to consider them anything but *Vultures*, though admitting that they are very aberrant in their structure. I therefore still keep them in the family Vulturidæ, and divide these birds into two subfamilies, one of them (Vulturinæ) containing the Old-world vultures, and the other (Sarcorhamphinæ) containing the American species. It is with the geographical range of these birds that we now propose to deal.

1. Vultur monachus. (Map I.)

V. monachus, *L.*; *Sharpe, Cat. B.* i. p. 3.

For the distribution of the Cinereous Vulture see Dresser's 'Birds of Europe' (pt. xiii.); but observe that the bird does not visit West Africa as there stated. The vulture mentioned by Fraser under the name of *V. monachus* is the small form of African Hooded Vulture, *Neophron monachus* (Temminck), peculiar to the Ethiopian region, into the north-eastern portion of which alone the present species ranges.

Palæarctic Region.

France. Occurs accidentally in Provence, Languedoc, and Dauphiné (*Degland & Gerbe*); inhabits the Spanish Pyrenees as well as the French, where it arrives in June, departing in October. It is not, however, uncommon on a fine winter day to see them appear in the neighbourhood of Bagnères-de-Bigorre, which fact seems to indicate that at least some individuals winter, if not in the French, at any rate in the Spanish Pyrenees. The localities which it seems to prefer in the western chain of these mountains are, according to M. Darracq, Mounts Orsamendi, Mousson, Reiboura, La Rhum, and especially the Aldules. . . . . A large band of them passed near Angers in October 1839, computed to number 100 individuals,

of which three were secured; and a still larger band was said to have passed two years previously. Both came from the north and journeyed towards the Pyrenees (*Jaubert et Barthélemy-Lapommeraye*).

Spain. By no means rare throughout Andalucia (*Saunders*); Castilles (*Lilford*); near Marbella and Cordova (*Lilford*); on the Spanish side of the Straits frequently to be seen in winter and early spring, though not nearly so common as the Griffon Vulture; it is more common near Seville than Gibraltar; some breed in Andalucia. Found by Lord Lilford nesting near Madrid (cf. *Irby's B. Gibr.* p. 28).

Portugal. Portugal (*Bocage*); Benavente (*Welwitsch*); Alemtejo (*Mira*); Collares (*Menezes*). Cf. *Souza, Cat. Accipitr. Lisb. Mus.* p. 30.

Balearic Isles. Resident in Mallorca (*Saunders*).

Switzerland and Savoy. Very rare in both these countries (*Bailly*).

Italy. Accidental in the Apennines; two specimens killed near Sarona, according to Durazzo; two killed in May 1863, near Ripatransone, in the province of Ascoli-Piceno (*Salvadori*).

Sardinia. Commonest Vulture in the island (*Brooke*).

Austrian Empire. Rarer than the Griffon, and occurs but seldom in the northern and western portions, Kloubouker district (*Brünner-Kreis*); Steinburg, in Carinthia; Southern Styria, accidental, once near Pettau; not rare in Siebenbürgen; doubtful whether it breeds in the High Tatra, Galicia; Hungary, near Ofen, common in the south (*Von Tschudi*); Banat (*Zelebor, Mus. Wien*). Cf. *Pelzeln, Geier und Falk.* p. 126.

Bohemia. Very rare (*Fritsch, J. f. O.* 1871, p. 175). Comes from the east; König-grätz; the Georgsberg near Laudnic; near Leitomitschl (*Fritsch*).

Germany. Once in Schleswig, once in Ober Lausitz, once in E. Prussia (*Borggreve*), Frankstadt (*Mähren*) in the end of May 1873; Hochwald, not far from Frankstadt; about the same time near Bielitz, Silesia, on the authority of Prof. Tolsky (*Von Tschusi, J. f. O.* 1874, p. 341).

Kurland. Shot by Forester Tamma (*Goebel, J. f. O.* 1873, p. 8).

Poland. Kielce and Rakolupy in the Government of Lublin; near Warsaw; near Lomze (*Taczanowski*).

Turkey. By no means a common species in Central Bulgaria; breeds in the thickly wooded hills that border on the Pravidy Valley (*Farman*); plentiful on the southern Danube (*Dresser*); common in Macedonia and Bulgaria, numerous in February (*Elwes & Buckley*); very common on the Bosphorus during migration (*Alléon & Vian*).

Greece. Breeds in Attica from Corinth to Livadia, resident also in winter (*Lindermayer*); breeds in the Cyclades, leaving in winter (*Erhardt*); Ionian Islands (*Lilford*).

Southern Russia. Steppes of Bessarabia (*Nordmann*); Crimea [?] (*Nordmann*); Tiflis (*Radde*). Sabanäeff did not meet with it in the southern Ural.

Asia Minor. Xanthus (*Fellows*); "only of very rare occurrence near

1*

Smyrna in summer; but I think I have seen it with other Vultures near Kaias (*Krüper, J. f. O.* 1869. p. 23).

Cyprus. (*Mus. Berol.*).

Palestine. By no means common, but a few scattered over the country (*Tristram*).

Egypt. Throughout the country, but nowhere abundant (*Shelley*). Von Heuglin only once saw it, near Benisouef, and considers it to be a very rare straggler.

Algeria. Not common, only seen singly or in pairs (*Loche*); in the mountainous parts, more especially in the neighbourhood of Constantine (*Taczanowski, J. f. O.* 1870, p. 36).

Morocco. Once near Tangier (*Favier*); a specimen, perhaps the identical one obtained by Favier, is in the Norwich Museum from Tangier (*Irby B. Gibr.* p. 28).

Northern Persia (*Blanford*).

Turkestan. All over the country, breeding. Found during the winter season in the north-western and south-western divisions of the country (*Severtzoff*). Cf. *Dresser, Ibis,* 1875, p. 98.

India. By no means rare throughout the north-west provinces, becoming more common in the country north-west of Delhi in the cold weather (*Jerdon, Ibis,* 1871, p. 234). Throughout the Punjaub, N.W. Provinces, Oudh, and Rajpootana, north-west of the Avavalli Hills in the cold weather, being most abundant in the far north-west, and becoming less and less common as you proceed south and west; a few specimens met with in that portion of the Central Provinces known as the Sagar and Nerbuddah territories, and in the northern or Shikarpoor collectorate of Sindh (*Hume*); once about twenty miles north of Ahmedabad (*Butler*); not yet received or heard of from Jodhpoor, Cutch, Kattiawar, or Sindh; and though it may doubtless occur within this vast tract, it can only be as a rare straggler (*Hume*); met with in the cold weather near the Sambhur lake (*Adam, S. F.* 1873, p. 367); once at Ajmere, and further north in Rajpootana it is not uncommon (*Hume*); Nepal (*Hodgson*); Darjeeling (*Jerdon*); Bhotan (*Hume*); Assam (*Jenkins, Mus. Calc.*).

Mongolia (*David*).

China. Peking (*David*); Ningpo (*Swinhoe, Mus. Brit.*); mouth of the Shanghai river and Chusan archipelago (*Swinhoe*).

2. Gyps fulvus. (Map II.)

G. fulvus (*Gm.*); *Sharpe, Cat.* i. p. 5.

The Griffon Vulture is here considered as one species, for after Mr. Gurney's observations (Ibis, 1875, pp. 88, 89) I do not think that my proposed separation of the Spanish bird as a distinct race can be upheld. In fact the way in which the Griffons wander would render it difficult to draw the exact range of one of the

G. fulvus group; and therefore I relinquish the name *G. hispaniolensis*; but at the same time the Spanish birds now alive in the Zoological Gardens show no inclination to paler colouring as they get older, but have the rufous coloration which induced me first to separate them. I further stated my belief that the Algerian Griffon (and probably the bird from North-east Africa also) would prove to be the same as *G. hispaniolensis* from Southern Spain. As to their habits of wandering, Canon Tristram says that during the Crimean war the Arabs believed that "the Vultures from all North-east Africa were gathered together to feed on Russian horses in the Crimea, and declare that very few '*Nissr*' were to be seen in their accustomed haunts." Nor is the Spanish Vulture free from these erratic habits; for Mr. Howard Saunders, writing of his trip to Southern Spain in 1868, says, "it had been a bad year for Vultures generally (they were away in Morocco feeding on Moors and Riffites)." I depended a great deal on the restricted habitat of *G. hispaniolensis* as a special feature; but if the bird wanders as stated above, then it is worthless; and moreover Mr. Gurney's researches (*l. c.*) tend to prove that the value of the Spanish bird as a race is very doubtful. Still the question is undoubtedly not yet settled, and a larger series will be necessary to determine the matter. I may remark, *en passant*, with regard to Mr. Gurney's statement that in the event of *G. hispaniolensis* proving distinct it must be called *G. occidentalis*, Bp., that this is certainly *not* so; for Bonaparte's name is taken from Schlegel's *Vultur fulvus occidentalis*, the types of which exist at Leiden, and are inseparable from the East-European bird. Pyrenean specimens *may* be the same as Sardinian; but my *G. hispaniolensis*, be it remembered, is the bird from *Southern* Spain.

Palæarctic Region.

Great Britain. Once, on the rocks near Cork Harbour. (For particulars, see Newton's edition of Yarrell's 'British Birds.')

France. Twice, in the department of the Seine Inférieure, in a plain at Saint Romain de Colbose, and near Bolbec (*Lemetteil*). Of frequent occurrence in Provence, and occasionally in Languedoc, Dauphiné, and the north of France; one killed near Armenbières in July 1828, and a young bird killed near Abbeville (*Baillon*); mountains of Provence, l'Ardèche, the Pyrenees, and especially the Cevennes; only a very accidental visitor in Savoy in autumn and spring. The localities where it has been met with are the mountains adjacent to Montiers, those of the Bauges, especially

those which feed large flocks of kids or sheep, such as the mountains of Tréloz, Orgeval, Rosannaz, and those of Faucigny, whence in 1846 M. Louis Coppier received a young male captured at Chamounix (*Bailly*); a regular migrant in the south of France (*Jaubert et Barthélemy-Lapommeraye*).

Lorraine. Very rare (*Godron*); killed once near Rémilly in 1842 (*Hollandre*).

Spain. Common in Southern Spain (*Saunders*); very plentiful near Gibraltar, nesting in colonies (*Irby*); Guadalquivir river (*Lilford*); Sierra de la Palmiterra near Marbella (*Lilford*).

Portugal. Said to be common in the southern districts, and seen on several occasions in the plains of Alemtejo (*Smith*); common in the last-named locality (*Bocage*).

Italy. Resident in the Alps of Nice and in Sicily, and of accidental occurrence all over Italy (*Salvadori*).

Sardinia. By no means uncommon; resident and breeding (*A. B Brooke*).

Austria. Often plentiful in Southern Hungary, Dalmatia, and Servia (*Fritsch*); Zwolfaxing (*Brezenheim*); breeding in the Banat (*Zelebor*); cf. *Pelz. Sitz. z.-b. G. Wien*, 1862, p. 129; a male procured at Neutitschein (Mähren) in October 1873 (*Von Tschusi*).

Bohemia. Comes from the eastward, particularly from Galicia and Hungary (*Fritsch. J. f. O.* 1871, p. 175).

Germany. Of accidental occurrence nearly all over Germany; Ober-Lausitz; Oldenburg, near Münster; Dantzig, &c. (*Borggreve*).

Poland. Rarer than *Vultur monachus*; near Samosé; near Warsaw (*Taczanowski*).

Russia. Courland; killed in the Mitau district (*Goebel*). According to Mr. Dresser, it was found by Sabanäeff "in the Kaslinsky Ural, where it breeds; and he further states that it ranges as high as 59° N. lat., having been obtained in the Pavdinskaia Dacha. He records the capture of one within sixty miles of Moscow in 1841, and says that sportsmen have assured him that they have seen this species in the district of Jaroslaf, which he thinks may have been the case. He also speaks of it as an annual migrant in the Government of Voronege." Uman, observed on the 26th of April, 1871 (*Goebel, J. f. O.* 1873, p. 131); near Tiflis (*Radde*); more or less common on all the shores of the Black Sea, more abundant in Bessarabia, only in small numbers on the mountains which border the south coast of the Crimea (*Nordmann*); abundant near Sevastopol in 1854 (*G. C. Taylor*).

Turkey. One of the commonest birds throughout Central Bulgaria; particularly partial to the Pravidy Valley (*Farman*); common in Macedonia and Bulgaria (*Elwes & Buckley*); common during migration, passing the summer in the interior, some few remaining (*Alléon*).

Greece. Resident (*Lindermayer*); abundant in Epirus (*Lilford*); Athens (*Merlin*); numerous near Missolonghi; breeds at Mount Varassoro and in the Klissouras of Aracynthus (*Hudleston*).

Crete (*J. H. Gurney*).

Syria. Beyrout (*Lauretta*).

Palestine. Common all over the country; plentiful in the hill-country of Judæa, and observed breeding in some ravines near the Dead Sea (*Tristram*).

Egypt. Plentifully distributed throughout Egypt and Nubia (*Shelley*).

Tunis. Not noticed in this regency (*Salvin*); occurs here and in Fez (*Von Heuglin*).

Algeria. Throughout the country (*Loche*); first seen at Souk Harras; several pairs also seen at Djebel Dekma and at "Khifan, Msakta;" very plentiful at Kef Laks and in the neighbourhood (*Salvin*); Laghouat (*J. H. Gurney, jun.*); Sahara (*Tristram*).

Morocco. Common at Tetran (*Drake*); occurs commonly in Tangier, both as a resident and on passage (*Favier*). "I did not see many Griffons in Morocco; but there were a few near Jebel Moosa in April" (*Irby*).

Central Africa (*Denham, Mus. Brit.*).

Ethiopian Region.

N.E. Africa. Resident along the coast of the Red Sea to 16° N. lat.; the whole of Egypt and Nubia; Abyssinia to 12,000 feet; singly in Kordofan, and on the Lower Blue and White Niles (*Von Heuglin*); Senafe in April; common in the Abyssinian highlands (*Jesse*); common in Samhar and on the Barka (*Antinori*). A species called the "Armed Vulture" is mentioned by Browne in his 'African Travels,' and is said to be extremely frequent in the country of Darfur, where it flies about in thousands (*cf.* 'Discoveries in Africa,' p. 441, 1849). This is perhaps the Griffon.

Arabia. Near Akabah, Peninsula of Sinai (*Wyatt*).

Persia. Plentiful in the mountainous parts and at Demavend (*De Filippi*); Southern Persia (*Blanford*).

Turkestan (*Severtzoff*). Dr. Severtzoff, one of the keenest ornithological observers I have ever met, seems to consider the Turkestan Griffon distinct; for he proposed the name of *G. rutilans* for it at one time (*cf.* J. f. O. 1870, p. 382 &c.).

Indian Region.

India. Mr. Hume has named the Griffon of India *Gyps fulvescens*, on account of its persistent bay colour; and I must say that the specimens in the Museum bear evidence of its distinctness. Taking into consideration the above observations of Dr. Severtzoff, the Indian Griffon (which, like *G. himalayensis* and *Otogyps calvus*, doubtless finds its way to Turkestan) is most probably distinct. Mr. Hume says, "I have found this bird very common throughout the Punjaub, Northern Rajpootana, and the north-western provinces, north and west of Etawah; and Colonel Tytler

has a young bird from Oraiee." As far as I can yet judge, it is essentially the vulture of the desert. In richly cultivated tracts, far from any sandy wastes, it is rare; but in the lower portions of the North-western Provinces and the Punjaub i is common, and in and on the borders of Bhawulpoor, Bikaneer, Jodhpoor, and Northern Jaipoor it abounds." Captain C. Marshall has found it breeding near Lahore. In Sindh, writes Mr. Hume, "this was the only species of Vulture that I actually shot and identified; but other species doubtless occur. Vultures, however, are very rare in Sindh, compared with what they are in Upper India." He then gives additional evidence as to the distinctness of *G. fulvescens* (cf. *Str. F.* 1873, pp. 148–150). Common near the Sambhur lake (*Adam*). Captain Butler, in his paper "On the Birds of Mount Aboo and Northern Guzerat," includes the true *Gyps fulvus* as "common on the plains," and he says that *G. fulvescens* of Hume is not very common. Mr. Hume observes that the latter species has been shot by himself at Deesa and Jodhpoor, and he has received it from Cutch, Kattiawar, and Sindh. With regard to Captain Butler's observation, it is worthy of note that he, a good field-naturalist, is acquainted with two species of Griffon on the plains of North-western India; and this is an additional argument in favour of the recognition of *G. fulvescens*. Kumaon (*Strachey*). Nepalese examples collected by Mr. Hodgson are in the British Museum. It is said to have been procured by Griffith in Assam; but Mr. Blyth suggests that, as Mr. Griffith also collected in Afghanistan, the Griffon may have come from the latter place, owing to some misapprehension as to the locality.

Upper Pegu. Perhaps occurs here. Cf. *Hume, Str. F.* 1875, p. 18.

3. Gyps himalayensis. (Map III.)

G. himalayensis, *Hume*; *Sharpe, Cat. B.* i. p. 8.

Hab. Himalaya Mountains from Cabool to Bhootan; breeds in the Himalayas in January, February, and March (*Hume*). Nepal (*Hodgson, Mus. Brit.*). "Not common between Gangaotri and Mussoorie; occasionally seen seated on its nest above the road, but so high up that it was almost out of rifle-shot, and at the opposite side of the narrow glen in which the river there runs. But for the white mark on the rock caused by the dung of the bird, I should not have noticed it. . . . . All the nests of this bird which I saw were inaccessible; and whether they contained young or not I could not tell. None of them occurred below Barahath; eyry the above referred to was not far from Danguli (*Brooks*); Major Lloyd noticed a Griffon about the cliffs and valleys of the Geerwar (Kattiawar) which he thinks may be this species (*Ibis*, 1873, p. 402). Turkestan; resident in the north-eastern district "comprising Semiratchje, Issikkul, the Upper Narin, Acksay, Kopal, and Vernoe" (*Severtzoff*, cf. *Dresser, Ibis*, 1875, p. 97). Its vertical range in Turkestan is "A winter visitant in district 3, a resident in district 4, where it breeds, and probably nests in districts 3, 4, and 5" (*Severtzoff, l. c.*). (For the explanation of the vertical range, *vide* Dresser, *l. c.*)

4. GYPS KOLBI. (Map III.)

G. KOLBI (*Daud.*); *Sharpe, Cat. B.* i. p. 8, pl. 1.

Hab. South Africa; pretty generally distributed throughout the Cape colony, still lingering even near Capetown (*Layard*); Gauritz river (*Atmore*). Caffraria (*Brehm*). Port Elizabeth and East London (*Rickard*). Algoa Bay (*Mus. Wien*). Common in Natal (*Ayres*). Extremely common from Natal up to the Matabili country (*T. E. Buckley*). Breeding in the Transvaal Republic (*Ayres*). Very numerous during a journey from Potschefstroom to the river Limpopo (*Ayres*). In all probability the species of Griffon met with in the Zambesi delta by Dr. Kirk (Ibis, 1864, p. 314). Sparingly found in Damara Land, chiefly observed in the vicinity of the sea above Oosop rocks in the lower course of the Swakop river. Mr. Andersson does not seem to have sent home any skins of this Vulture, with which, however, he was doubtless thoroughly well acquainted. Mr. Chapman states that it is found nearly all over South Africa, but is more common to the south and east than in either Damara or Great Namaqua Land.

N.B. It has not yet been met with by Anchieta in Mossamedes or Benguela, and seems to be much rarer on the western side of the continent. It was probably at one time more frequent in the western parts of the Cape colony, as Sir Andrew Smith, writing in 1829, speaks of it as occurring in great abundance throughout *the whole* of South Africa (S. Afr. Q. Journ. i. p. 11).

There is no valid evidence of its occurrence out of the South-African subregion; and its reputed capture in North-east Africa requires confirmation, while Von Pelzeln (Sitz. z.-b. G. Wien, 1862, p. 130) very properly doubts Erhardt's statement of its occurrence in the Cyclades (Naumannia, 1858, p. 16).

5. GYPS RUEPPELLI. (Map IV.)

G. RUEPPELLI, *Brehm*; *Sharpe, Cat. B.* i. p. 9.

Hab. N.E. Africa. Takar and Southern Nubia; Kordofan, Senaar; Abyssinia; Djak on the White Nile, less abundant on this river; comes to the sea-coast in Samhar, and occurs on the high mountains of Sémien and in the Galla countries up to 10,000 feet (*Von Heuglin*). Angollála, Shoa, October 1842 (*Harris, Mus. Brit.*). Autrub, on the Blue Nile (*Antinori*). The great majority of the Vultures met with in the Abyssinian Highlands were probably of this species, which was by no means confined to the high tableland; abundant in the Anseba valley at from 4000 to 4500 feet; Rairo, north of the Lebka valley, at 3000 feet (*Blanford*). South Africa, rare; seldom found to the south of the Orange river (*J. Verreaux*). Port Natal (*J. Verreaux, Mus. Lisb.*); rare in this part of the colony (*Ayres*).

S.W. Africa. Ondonga, Ovampo Land, Nov. 1866.

I cannot help thinking that this is the identical specimen mentioned by Professor Schlegel (Revue, Accipitr. p. 140) as *Vultur fulvus kolbei.* When I gave up collecting large African birds in order to restrict myself to Passeres and Picariæ, most of the former passed into the hands of Mr. Frank, by whom they were offered to the Leiden Museum. I may state therefore that the bird in question was examined both by Mr. Gurney and myself, and identified as *G. rueppelli*, which, as I have observed in my 'Catalogue,' when adult, is unmistakable, but when young more nearly resembles the other Griffons.

6. Gyps indicus. (Map IV.)

G. indicus (*Scop.*); *Sharpe, Cat. B.* i. p. 10.

Hab. All over India, more rare towards the south, and then chiefly near mountains; not rare on the Neilgherries, where it breeds (*Jerdon*). Kattiawar (*Lloyd*); breeds at the Taragurh Hill near Ajmere, and in the Gaimookh cliffs on Mount Aboo (*Hume*); very common near the Sambhur Lake (*Adam*); common in Oudh and Kumaon (*Irby*); Nepal (*Hodgson*); Deccan (*Sykes*); probably occurs in the Wardha valley (*Blanford*); Assensole, Chota Nagpur district (*Brooks*); breeds near Calcutta (*Blyth*); very abundant in Burmah (*Jerdon*); Arakan (*Blyth*); Zwagaben Mountains (*Beavan*); nowhere in great numbers in Upper Pegu, but is not uncommon near villages (*Oates*); Siam (*Schomburgk*); an adult and a nestling procured by Mouhot in Siam, 200 miles N.E. of Bangkok, in the Norwich Museum (*Gurney, Cat. Rapt. B. Norw. Mus.* p. 74); Malayan peninsula: "I have seen two specimens of this Vulture in a Malacca collection. No doubt a Vulture of any kind is there rare, or it would not have been deemed worthy of preservation; according to Sir Stamford Raffles, Vultures are rare on the west coast of Sumatra, but are occasionally seen on the Malayan peninsula and at Penang" (*Tr. Linn. Soc.* xiii. p. 277; *Blyth, B. Burma,* p. 64).

Mr. Hume believes that two distinct birds are generally comprised under the name of *G. indicus*, and he has named one of them *G. pallescens.* Captain Butler says that the Long-billed Brown Vulture is very common near Mount Aboo and in Northern Guzerat; and Mr. Hume states that the bird from these parts is the pale cliff-breeding *G. pallescens,* and not the so-called *G. indicus* of Scopoli, "so common in the eastern portions of our empire." He states that he has received it from Jodhpoor, Cutch, and Kattiawar, but not Scindh as yet.

7. Pseudogyps bengalensis. (Map V.)

P. bengalensis (*Gm.*); *Sharpe, Cat. B.* i. p. 11.

Hab. The commonest Vulture in India; in immense numbers all over the country, extending into Assam and Burmah (*Jerdon*). Candahar (*Hutton*); commonest Vulture in Kattiawar (*Lloyd*); very plentiful both on the hills and in the plains near Mount Aboo and Northern Guzerat (*Butler*); common all over Rajpootana, the North-west Provinces, and the major portion of the Punjaub (*Hume*); very common near the Sambhur Lake; "a great quantity of camels and bullocks which die near here attract these birds in great numbers" (*Adam*); common throughout the year in Oudh and Kumaon (*Irby*); Nepal (*Hodgson*); Chota Nagpur (*Ball*): Wardha valley near Chanda (*Blanford*); Deccan (*Sykes*); Travancore (*Elwes*); Burmah, often seen in great numbers, even in the suburbs of large towns (*Mason*). "I noticed a few about Akyab only. It abounds as much in Siam as in Bengal" (*Blyth, B. Burma*, p. 65). A specimen received from Thayetmyo; occurs as far south, at any rate, as Tavoy (*Hume*); Pabyouk, Tenasserim; occasionally seen (*Davison*); Province Wellesley (*Cantor*).

8. Pseudogyps africanus. (Map V.)

P. africanus (*Salvad.*); *Sharpe, Cat. B.* i. p. 12.

Hab. From the Soudan northwards to Chartoom; Western Abyssinia; Southern Kordofan and the districts of the White Nile and Gazelle River (*Von Heuglin, Antinori*); Senaar (*Kotschy, Mus. Wien*, cf. *Pelz. Sitz. z.-b. G. Wien*, 1862, p. 130). Nubia (*Baron Von Mueller, Mus. Stuttg.*, cf. *Calwer, Cat.* p. 2). Senegal, Dakar (*Marche*, cf. *Bouvier, Cat.* p. 5, *Sharpe, Cat. B.* i. p. 13). S.W. Africa; Humbe on the Cunene river (*Anchieta*, cf. *Bocage, Jorn. Lisb.* 1874, p. 47).

9. Lophogyps occipitalis. (Map VI.)

L. occipitalis (*Burch.*); *Sharpe, Cat. B.* i. p. 15.

Hab. N.E. Africa. It affects only the wooded districts of the equatorial north-east, the Abyssinian coast-land, the districts of Bogos and Maria, Central Abyssinia, Senaar, Southern Kordofan, and the countries about the White Nile and Gazelle River westwards as far as Kosanga. It wanders more rarely into the southernmost parts of Nubia and Takah and the Bisharim steppes; it is not rare near Massowa; not observed in Somali Land (*Heuglin*). Senaar (*Kotschy, Mus. Wien*). Nubia (*Clot-Bey, Mus. Lugd.*). Mansura, Barka river, Anseba river, Keren, Bogos Land (*Antinori & Beccari*). *W. Africa.* Senegal (*Mus. Lugd.*). Bissao (*Beaudouin, Calheiros*). Fernand Vaz (*Marche*). *S. Africa.* Not found within the limits of the Cape colony (*Layard*); rarest of the Vultures in Natal (*Ayres*); plentiful near Kuruman (*Chapman*): breeds in

the Transvaal (*Ayres*); originally obtained in the Bechuana country by Burchell; not a very common species from Natal to the Matabili country (*T. E. Buckley*); near the Seko-kaama Hill, the Koppes, S.W. of Lake Ngami, March 2, 1862 (*Baines*): "I do not remember to have met with this fine Vulture in Damara Land, but have observed it, though only at a distance on a few occasions, in Great Namaqua Land" (*Andersson*).

10. Otogyps auricularis. (Map VII.)

O. auricularis (*Daud.*); *Sharpe, Cat. B.* i. p. 13.

Hab. S. Africa; pretty generally distributed in South Africa (*Layard*); breeding near Beaufort in August (*Jackson*); Natal (*Ayres*); Transvaal (*Ayres*); Modder river, near Bloemfontein, Orange Free State (*Exton*); the commonest Vulture in Damara and Great Namaqua Lands, and also found in all the parts bordering those countries (*Andersson*); probably in the Zambesi (*Kirk*).

N.E. Africa. Not found in Northern Egypt, but in the middle and southern provinces tolerably plentiful; common in Nubia, Northern Kordofan and Senaar; in Takah and the whole of Abyssinia up to 12,000 feet in the latter country—in the district of the middle and upper White Nile apparently entirely absent—on the Red-Sea coast seemingly only of accidental occurrence (*Heuglin*); met with on the highlands of Abyssinia at considerable elevations, and occasionally seen in the Anseba valley at lower levels (*Blanford*); Shoa (*Harris, Mus. Brit.*); Khartoum (*Vierthaler*); Senaar (*Reitz, Mus. Wien*).

W. Africa. Cape-Verd peninsula, Senegal (*Marche*). Cf. *Bouvier, Cat.* p. 2.

N. Africa. Sahara; constant resident, though in limited numbers (*Tristram*); breeds to the S.W. of Biskra, remains all the year round in the district between the Mzab country and the oasis of Waregha, lat. 32° N. (*Tristram*); probably to be found in the southern part of Morocco (*Irby*).

Palestine. Mount Lebanon (*Mus. Marseilles*).

Europe. Once near Arles, S. France (*Jaubert & Barthélemy-Lapommeraye*). The same gentlemen state that it has once nested in Spain. The Norwich Museum has a specimen said to have been killed in Greece (cf. *Gurney, Cat. Rapt. B.* p. 58).

N.B. It will be seen that I have treated all the eared Vultures of Africa as being of one species, the only specific difference being the greater amount of wattled skin on the sides of the bare neck in South-African specimens. Dr. Exton has some remarks on this subject (Cape Monthly Mag. 1875, p. 259), and considers that the preparation of the skin has much to do with the appearance of the birds when preserved.

11. Otogyps calvus. (Map VII.)

O. calvus (*Scop.*); *Sharpe, Cat. B.* i. p. 14.

Hab. Found commonly throughout India, extending into Burma, but by no means abundant in individuals (*Jerdon*); not uncommon in Kattiawar (*Lloyd*); found in the hills and plains near Mount Aboo and in northern Guzerat (*Butler*); Jodhpoor, Cutch, Kattiawar, Sambhur, and Rajpootana generally, but not as yet from Sindh (*Hume*); common near the Sambhur Lake; "in the month of March I saw this bird sitting on its nest, which was in the face of a rock in the hills near the town of Nawa" (*Adam, S. F.* 1873, p. 367); Etawah, breeding at Ajmere (*Hume*); between Simla and Mussoorie (*Tytler, Ibis*, 1871, p. 194); "seen occasionally between Mussoorie and Gangaotri, and far into the hills, where one would not expect to see a plains-loving Vulture. I saw one or two soaring high above Derali" (*Brooks, S. F.* 1875, p. 228); frequently noticed at Nynee Tal and Almora (*Brooks*); found in Oudh and Kumaon throughout the year, breeding in the cold season (*Irby*); Nepal (*Hodgson*); from the neighbourhood of Calcutta (*Mus. Ind.*); not uncommon in Chota Nagpur, but more than a pair rarely observed at a time (*Ball, S. F.* 1874, p. 376); Wardha valley (*Blanford, J. A. S. B.* 1871, p. 270); Deccan (*Sykes*); breeding near Gotekindee, Sattara district (*Davidson, S. F.* 1874, p. 336); Travancore (*Elwes*); Khasia and Garo hills, six or eight specimens observed at Chatak (*Godwin-Austen, J. A. S. B.* 1870, p. 265); not a common species in Burma (*Blyth, B. Burma*, p. 64); Upper Pegu (*Oates, Feilden*); Siam (*Schomburgk*). Turkestan, an occasional summer visitant to district III. ("the north-western district comprising Karatau, the western Thianshan mountains, the upper portions of the rivers Aris, Kedess, Chirchick, and their tributaries, the lower Syr-Daria, from the source of the Aris to Lake Aral and the delta of the Syr-Daria"): *Severtzoff*; cf. *Dresser, Ibis*, 1875, p. 97. The "vertical range" is given in the same paper as follows: "an occasional straggler during summer in district II. (the cultivated districts, grassy steppes, and gardens to 3000 or 4000 feet altitude)."

12. Neophron percnopterus. (Map VIII.)

N. percnopterus (*L.*); *Sharpe, Cat. B.* i. p. 17.

Palæarctic Region.

Norway. Buffon records a specimen from this country.

Great Britain. Accidental visitor; once in October 1825 near Kilve in Somersetshire; a second in September 1828. For particulars, *cf.* Newton's edition of Yarrell, vol. i. p. 7.

France. Of doubtful occurrence in the department of the Seine Inférieure (*Lemetteil, Cat.* i. p. 82). Tolerably common in many places in the Pyrenees, on the lofty mountains of Provence, in the departments of the Var and the Basses Alpes; it lives also on those of L'Isère, La Drome,

L'Hérault, Gard, Bouches-du-Rhône, L'Ariége. Lastly, Abbé Vincelot records it as an accidental bird of passage in the department of Maine-et Loire; it arrives in April to breed in the above places, and leaves at the end of the summer (*Degland et Gerbe, Orn. Eur.* i. p. 13). Not common in Savoy or Switzerland, and only comes during the summer, arriving with the first days of March (*Bailly*).

Spain. Very common in Andalucia and probably all other parts of Spain in summer (*Lilford*); abundantly distributed near Gibraltar (*Irby, B. Gibr.* p. 31); common in Southern Spain except in winter, when but few remain (*Saunders*).

Portugal. Common in the Sierra de Louza (*Bocage*); apparently rare in Algarve (*Rey, J. f. O.* 1872, p. 141).

Balearic Isles. Mallorca, May 2 (*Von Homeyer*).

Italy. Salvadori states that it is resident in the district of Nice in the Siena Maremma, especially about Cape Argentaro, where Save found it breeding, and in the Roman Campagna. It seems to run down the west coast; but to the east of the Apennines it does not occur, with the exception of a single example at Taranto. It is found in the mountains of the Neapolitan districts; and recent investigations have shown, according to Prof. Doderlein, that it is by no means rare, although somewhat local, in the island of Sicily, in the mountainous districts of which it nests. Said to be pretty common on the Monte Argentaro and in the Siennese Maremma, but does not occur near Pisa (*Giglioli*).

Malta. Merely an accidental visitor (*Wright*).

Austrian Empire. Appears to be not so rare in Southern Hungary. Herr O. von Hermann obtained three specimens on the 12th of July near Braziás (*Von Tschusi, J. f. O.* 1874, p. 341).

Turkey. "In the Pravidy valley, in the neighbourhood of Shumla; and wherever the hills show a broken face of rock, there I found this Vulture pretty abundant; but in the open country and wooded districts, though occasionally to be met with, it is comparatively scarce; arrives in March, leaves in October" (*Farman*); plentiful in Bulgaria (*Elwes and Buckley*); abundant in and about Constantinople in spring and summer (*G. C. Taylor, Ibis,* 1872, p. 228); common in spring in Turkey, arriving by thousands (*Alléon*).

Greece. Very common in summer on the mainland (Albania &c.); breeds in Corfu and in Epirus; first observed at Prevesa, in the Gulf of Arta, on the 15th of March, 1857 (*Lilford*); Dobrudscha (*Hudleston*).

Crimea (*Pallas*).

Asia Minor. Not rare near Smyrna, arriving in March (*Krüper, J. f. O.* 1869, p. 22).

Palestine. Universally distributed throughout Palestine in summer (*Tristram*); strictly migratory; plentiful in Gilead and Moab (*Tristram*).

Egypt. Extremely abundant throughout Egypt and Nubia (*Shelley*); breeds among lofty crags along the banks of the Nile in Nubia (*Leith Adams*).

Sinaitic Peninsula. Generally distributed, but not very common (*Wyatt*).

Algeria. Very rare in winter, but found in summer in the Sahara (*Tristram*). Extensively distributed in Algeria and Tunis; breeds (*Salvin*).

Morocco. Common in Tangier; breeds near Tetuan (*Drake*); appears near Tangier in flocks during migration, some remaining to nest in the vicinity, awaiting the return of the autumn migration to winter probably in the interior of Africa. They pass over to Europe from February to April, returning in August and September (*Favier,* cf. *Irby, B. Gibr.* p. 31).

Canary Islands &c. Common in all the Canarian Group; breeds in Teneriffe and probably in the other islands (*Godman*). Madeira (*Vernon Harcourt*).

Persia &c. Rare in Persia to the south of Elburz, frequent in the Caucasus and at Ghilan (*Filippi*); the first specimens seen at Bakou in the Caucasus in spring, and afterwards on the mountains of Talyche, but never were more than two together (*Ménétriés, Cat.* p. 27).

Turkestan. Breeds in the whole country, and is found during summer in the district "from 600 to 1000 feet above the sea-level, comprising the salt-plains, the cultivated districts, grassy steppes, and gardens to 3000 or 4000 feet altitude, and is said to breed in the larch-woods, apple- and ash-groves of the Karatau and the lower Thian-Shan mountains" (*Severtzoff,* cf. *Dresser, Ibis,* 1875, p. 99).

Ethiopian Region.

N.E. Africa. Commonest bird of prey in Egypt, Arabia, and the Somali coasts; in the interior of Abyssinia to about 11,000 feet; on the Upper White Nile and Gazelle River only accidental (*Heuglin*); found on the coast of Egypt between Cosseir and Suakin, coast of Abyssinia, Danakil country between the peninsula of Buri and the Gulf of Tadjura, Somali coast; South Arabia (*Heuglin*); Zoulla and Senafé (*Blanford*); Angollala, Shoa (*Harris*).

E. Africa. Zanzibar (*Von der Decken*).

S. Africa. Zambesi district (*Kirk*); very rare in Natal (*Ayres*); said to be common in the interior of Cape colony and about Namaqua Land—at the western end of the colony decidedly scarce—Hopefield, Malmesbury district (*Layard*); Kingwilliamstown (*Trevelyan*); breeds near Swellendam (*Atmore*); not uncommon in Damara and Great Namaqua Lands and the parts adjacent, more especially in the neighbourhood of the coast (*Andersson*); Mossamedes (*Sala, Mus. Lugd.*).

West Africa. Absent.

Cape-Verd Islands (*Bolle, Dohrn*). St. Iago (*Mus. Lisb.*). Mayo (*Bouvier*).

13. Neophron ginginianus. (Map VIII.)

N. ginginianus (*Lath.*); *Sharpe, Cat. B.* i. p. 18.

This species differs from the ordinary Scavenger Vulture of

Europe in having a yellow instead of a blackish bill. Mr. Brooks writes (Ibis, 1870, p. 290):—" The distinction of the dark bill does exist, but only in certain localities in India. When at Delhi the other day I observed that some of these birds had dark bills, others not so dark, and some had light ones. The difference may be due to some peculiarity of climate; that it is specific I do not believe. I shot one bird at Delhi which has a dark bill and claws, the cere of a deeper colour than the rest of the bare skin, and a few small white feathers on the throat; but had I chosen, I could also have procured close to this bird one with a light bill, and a complete representative of our more southern bird. In size, proportion of wings to tail, and other points these birds vary a little; and in colour of the bill they vary much. I could not procure a black-billed one here at Etawah, nor could I at Almorah, which is much further north than Delhi; but at Delhi the black bills are the rule. The one I shot has a dark bill; but I saw many others with the point of the bill nearly, or quite, black.

"Between this and Delhi there must be a part of the country where light and dark bills will be equally common; and north and west of Delhi there will be a place where the weakly birds with pale bills will never be found. I have no doubt that dark and light-billed birds will sometimes be found breeding together, a dark-billed male and a light-billed female, or *vice versâ*. Mr. Blyth, not having seen dark-billed birds in India, was quite justified in thinking then that our pale-billed bird was of another species. With the aid of a powerful glass I examined every *Neophron* I saw at Delhi; and few indeed had light bills."

The above interesting note shows that in all probability the two Neophrons grade into each other; and it is certain that the range of the two is continuous; for Mr. Hume writes:— "In Sindh, at Gwader, and at Muscat it swarms wherever human habitations are found, and in the most uninhabited parts, even in the Kelat Hills a pair may occasionally be found." Again, he writes that it occurs throughout Sindh, Kutch, Kattiawar, Jodhpoor, and Rajpootana. Captain Butler says that it is a very common species both on the hills and in the plains near Mount Aboo, and in northern Guzerat. According to Mr. Blyth, it is a summer visitor to Afghanistan; and Mr. Ball has lately noticed it from the Suliman Hills, west of Dera Ghazi Khan; but he collected no specimens. He writes, "It was more abundant

in the Sulimans than in any other part of India which I have visited. This was probably due to the fact of the absence or extreme rarity of any of the true Vultures" (Str. F. 1875, p. 205).

Not uncommon in Kattiawar, but somewhat locally distributed (*Lloyd*).

Occurs in the N.W. Himalayas, and is common in the large stations up to at least 9000 feet elevation (*Jerdon, Ibis,* 1871, p. 237).

Between Simla and Mussoorie; not common. I did not see more than a dozen together at all heights (*Tytler, Ibis,* 1871, p. 194).

Breeds at Murree; a nest found in a cliff in May, with two fresh eggs, at an elevation of about 4000 feet (*Cock & Marshall, S. F.* 1873, p. 349). Noticed this species as high as Danguli between Mussoorie and Gangaotri (*Brooks, S. F.* 1875, p. 228). Nepaul (*Hodgson*); in great numbers in Oudh and Kumaon; frequently seen in Kumaon, and is common at Nynee Tal and Almora; seldom, if ever, seen near Calcutta (*Irby*).

Abundant on the plains of India; rare and accidental below the tideway of the rivers in Lower Bengal (*Blyth*); common in villages in Chota Nagpur, especially about those of the untidy aborigines (*Ball, S. F.* 1874, p. 377). Whardha valley; breeding in a cliff at the side of the Whardha river on April 14; again on a tree on May 2 (*Blanford*); Deccan (*Sykes*); Travancore (*Elwes*).

Ceylon. One specimen at Newara Ellia (*Vincent Legge, S. F.* 1875, p. 195).

14. Neophron pileatus. (Map IX.)

N. pileatus (*Burch.*); *Sharpe, Cat. B.* i. p. 18.

South Africa. Not found in the colony (*Layard*); but few seen in Natal (*Ayres*); not common in Damara Land, but becomes more numerous towards the Orange river (*Andersson*); universal in the Zambesi region (*Kirk*).

W. Africa. River Gambia (*Bravo*); Raffisque, Senegal (*Marche*); Bissao (*Pimenta, Mus. Lisb.*); Sierra Leone (*Ussher, Marche*); very common on the Gold Coast (*Ussher*); Aguapim (*Riiss*); mountains of Aguapim at Aburi, also on the Wuri, Cameroons (*Reichenow*). Reichenow is surprised to find that Ussher mentions this Vulture as being common at Cape Coast, since he did not meet with it at Accra and other places on the Gold Coast (*J. f. O.* 1874, p. 384); Shelley and Buckley, however, record it as abundant at Cape-Coast Castle all the year round, being never molested; but they also note its absence near Accra (*Ibis,* 1872, p. 292); River Volta (*Ussher*); Lagos (*Ussher*); river Niger (*Baikie*); S. Thomas (*Lopez de Lima*).

N.-E. Africa. In N.-E. Africa northwards to 14° or 17° N. lat.; in southern Arabia, Sambar, and the mountains of the Beni Amer, commoner than *N. percnopterus* on the White Nile (*Heuglin*); breeds on the Blue Nile in December (*A. Brehm*); Senaar (*Kotschy, Vierthaler*); Shoa (*Harris*); Keren, Bogos (*Antinori & Beccari*) breeds near Massowa

(*Duke Ernst*); Zoulla (*Blanford*); common from the coast to the highlands of Abyssinia (*Jesse*); islands of the Dahalak group, very common in marshy country near Chor-Mosgan, Somali, not seen about Tadjura and Berbera (*Heuglin*).

E. Africa (*Von der Decken*). No exact locality recorded.

15. Sarcorhamphus gryphus. (Map I.)

S. gryphus (*L.*); *Sharpe, Cat. B.* i. p. 20.

Hab. "The Condor is known to have a wide range, being found on the west coast of South America, from the Strait of Magellan, throughout the range of the Cordillera, as far, according to M. d'Orbigny, as 8° N. lat. On the Patagonian shore the steep cliff near the mouth of the Rio Negro in lat. 41° was the most northern point where I ever saw these birds or heard of their existence; and they have wandered about 400 miles from the great central line of their habitation in the Andes. Further south, among the bold precipices which form the head of Port Desire, they are not uncommon; yet only a few stragglers ever reach the coast" (*Darwin*). Chili, from the Strait of Magellan to the Atacama desert (*Philippi*); found in all the provinces of Chili, and very abundant in the elevated valleys of the Andes (*Brydges*). "The Condor I first saw at Cape Possession, considerable numbers of the bird nesting on high ledges of the cliffs in this vicinity" (*Cunningham*); "in all the western parts of the La-Plata countries on the Cordilleras, but also on the high ranges in the interior—namely, on the Sierra de Cordova and Aconquija, where I myself saw the bird" (*Burmeister*); Peru (*Mus. Philad.*); Ecuador (*Orton*); Columbia, "We saw the Condor as we were crossing the Paramo of Pamplona above Vetas, altitude 11,500 feet" (*Wyatt*).

N.B.—The Condor is here treated as a single species; but there are probably three species or races—the first from Magellan Strait and Chili, the second from Peru, and the third from Ecuador and Columbia. Since I named the last *S. æquatorialis*, I have seen no additional evidence as to its distinctness as a species, and the question remains *in statu quo*. I recently examined a bird in Mr. Boucard's house from Columbia; but the specimen was evidently young, and could not be compared with the southern form, of which we have only adults in the Museum.

16. Cathartes papa. (Map II.)

C. papa (*L.*); *Sharpe, Cat. B.* i. p. 22.

Hab. Southern Mexico (*Sallé*). Vera Cruz, S. Mexico (*Boucard*). Three specimens captured in the mountains near Acaponetti, about eighty miles south-east of Mayatlan (*Grayson*, cf. *Lawrence, Mem. Bost. Soc.* ii. p. 303). Honduras, procured at Omoa and in the mountains of San Pedro, not common about Omoa, but more frequently seen in the less-inhabited districts in

the centre of Vera Paz, frequenting the higher ranges (*Leyland*). Guatemala: Coban, Vera Paz; found only in the coast districts, does not extend its range into the central districts (*Salvin*). Costa Rica; only in the warmer and more retired parts of the country, especially in the neighbourhood of the coast; seen in San Juan del Norte, and some specimens on the western side (Pacaca) (*Von Frantzius*). Panama (*M'Clelland*); New Granada (*Salmon*); Bogotá (*Sclater*); Santa Martha (*Verreaux*); Trinidad, met with on a journey from Port of Spain to the east coast (*E. C. Taylor*); British Guiana (*Schomburgk*); by no means common in Demerara (*Bonyan*). Brazil; Rio Itapemirini, Rio Perahype, Rio Ilheos (*Prince Maximilian*); Lagoa Santa (*Burmeister*); Rio de Janeiro (*Mus. Lisb.*); Minas Geraes (*Lund*); Ytararé (February), Murungaba (March), Rio Araguay (October, November), Jacobina (July), Caiçara (October), Engenho de Capt. Gama (September), Borna, Rio Branco (April, May), Serra Carauman (July) (*Natterer*). All the forests of the Lower Amazons (*Wallace*); Xeberos and Santa Cruz, Huallaga river, E. Peru (*E. Bartlett*). The whole of Brazil, Western Peru, and Bolivia; towards the south it extends its migrations to the 28th degree of lat. to Paraguay and Corrientes, where, however, it becomes rare, never found to the west of the Andes (*D'Orbigny*).

17. CATHARISTES ATRATUS. (Map III.)

C. ATRATUS (*Bartr.*); *Sharpe, Cat. B.* i. p. 24.

N. America. "Quite common along the Atlantic and Gulf coasts from North Carolina to Mexico. It does not occur on the Pacific coasts of the United States, though given by Douglas as being abundant on the Columbia river; indeed it has not, that I am aware of, been detected west of the Rocky Mountains. It is, however, as Dr. Gambel states, very common about the Gulf of California; and at Mazatlan, particularly, he saw it round the town in large companies. On the Atlantic coast it is not often met with further north than Wilmington, N.C. I could not detect it near Norfolk, Va., nor could I understand that it was known ever to occur there. Accidental specimens have been taken, two on the coast of Massachusetts and one in the Bay of Fundy; but such occurrences are very rare. Along the coast of all the Southern States, from North Carolina to Texas it is much more abundant than *R. aura,* even where, in the interior of the same state, it is far less frequent. Along the banks of the Mississippi and its tributaries, as far as Ohio to the east and Illinois to the north, it is found more or less abundantly at certain seasons. It is met with in several of the West-India Islands, though rare in Jamaica" (*Brewer,* in the 3rd vol. of *N.-American Birds,* p. 352); Florida (*G. C. Taylor*); on the Rio Grande, Texas, about equally common with *C. aura,* but towards San Antonio, much less so (*Dresser*).

C. America. Orizaba, Mexico (*Botteri*); Mazatlan, "may be met with in all Mexico, but is more common in the *tierras calientes* (*Grayson,*

cf. *Lawrence, Mem. Bost. Soc.* ii. p. 303); everywhere in Guatemala (*Salvin*); very abundant in Honduras in the villages (*G. C. Taylor*); in great numbers about Omoa (*Leyland*); breeds in Costa Rica, where it is a very common species in the neighbourhood of almost every inhabited place (*Von Frantzius*); Panama (*M'Clelland*).

West-India Islands. Cuba (*Gundlach*); Jamaica, recently arrived (March); not seen there by Mr. Gosse; not in Porto Rico (*E. C. Taylor*), nor in any of the islands between Trinidad and S. Thomas (*E. C. Taylor*).

S. America. Very common in Trinidad and Venezuela (*E. C. Taylor*); widely distributed in British Guiana (*Bonyan*); Surinam (*Mus. Lugd.*); New Granada (*Mus. Lugd.*); Columbia, Ocaña (*Wyatt*); Ecuador, in hundreds at Babahoyo, Perruche, common in the pueblo, sitting on the roofs, and above Puellaro (*Fraser*); Peru, common throughout the country all the year round, more especially in the dry season, when the Peruvians are collecting and drying *Vacca marina* and fish (*E. Bartlett*). "We have met with this Vulture in the whole of Brazil, in the Republic of Uruguay, in Patagonia, Paraguay, Chili, Peru, Bolivia. It is common at Maldonado, in the Banda oriental of La Plata, but is never found near Buenos Ayres. It only commences to become common again in Patagonia, which caused Azara to say that it was not found to the south of the La Plata. We can only attribute its disappearance to the absence of trees or bushes in the Pampas; for it reappears in numbers on approaching the Cordillera of the Andes. It disappears at once, and is seldom seen in the elevated parts of this Cordillera. We have met with it more often and in large troups in Patagonia, on the banks of the Rio Negro, near the towns in Chili, and particularly on the maritime coasts of Peru, as well as in the interior in the plains of Bolivia; but it is rare in the mountains" (*D'Orbigny*). Rio Janeiro (December), Ypanema (April, May) (*Natterer*); Para (*Wallace, Layard*); Lagoa Santa (*Lund*); Catangallo (August) (*Euler*); Santa Catharina (*Berlepsch*); Rio Negro, Patagonia (*Hudson*); never found to the south of this river, never seen in Patagonia or Tierra del Fuego (*Darwin*); common in the whole of Brazil, spread through the La-Plata States, but more plentiful in the east and north than in the west and south, nowhere so common as in Brazil (*Burmeister*); comes into the province of Santiago and the northern parts of Chili, but not in such innumerable quantities as in Peru, where thousands of these birds are found in the streets of Lima (*Bibra*); found on the eastern sides of the Andes near Mendoza, and occasionally seen in the province of Colchagua (*Brydges*); common in Mendoza; not seen in Chiloe or on the west coast of the continent to the south of that island (*Darwin*). Prof. Cunningham, however, found this Vulture very common in Chiloe; so that perhaps it has been introduced there since Mr. Darwin's voyage.

The British Museum has a skin said to be from Buenos Ayres; but it is probably from some adjacent locality.

18. Rhinogryphus aura. (Map VI.)

R. aura (*L.*); *Ridgw. N. A. Birds*, iii. p. 344.

Œnops aura (*L.*); *Sharpe, Cat. B.* i. p. 25.

Hab. Dr. Coues gives a very concise account of the range of this bird, which I extract from his 'Birds of the North-west:'—"Although more particularly an inhabitant of the warmer parts of America, and most numerous in the Southern States, along with the Black Vulture (*Catharistes atratus*), the Turkey Buzzard is nevertheless found all over the United States and a little way into British America. On the Atlantic coast its ordinary limit is Long Island; Audubon's data were incomplete in rendering his statement that it is never seen beyond New Jersey. It has been repeatedly observed in southern New England, and at least once in Maine. Its Nova-Scotia record, as remarked by F[illegible]rewer, is vague, and probably unfounded; and even its New-England occurrences are rare, if not altogether casual. It is included in Mr. M'Ilwraith's list of the birds of Hamilton, Canada West, with the remark that it is a regular summer visitor to the extensive flats near Chatham and along the shores of Lake Saint Clair. In the interior it regularly goes further north than on the coast. Mr. Trippe found it abundant in Minnesota, where it breeds; and Sir John Richardson's well-known record fixes its northern limit at about latitude 53°, in the region of Saskatchewan, where it arrives in June. The highest point where I ever saw it myself, up to the date of present writing, was Fort Randall, lat. 43° 11′, on the Missouri: at the close of the most terrific storm of the season of 1872-3, memorable for its severity, five or six birds came sailing over the fort. This was on the 15th of April; none had been observed previously after October; and I do not think it usually passes the inclement season at this point.

"This brings us to consider the resident range of the species as compared with its summer dispersion. It has not been observed to winter on the Atlantic beyond New Jersey, and even in that State is more numerous in summer than in winter. But at Washington, D. C., my home for a number of years, where the bird is very common, I noticed no material diminution of its numbers during the colder months. The same is the case in both the Carolinas, where I constantly observed it during a residence of three or four years. In the interior it appears to winter higher up; thus Mr. Trippe saw it late in October, and again in December, in Minnesota. But the last may have been an unusual occurrence; probably the parallel of 40°, or rather the isothermal corresponding to this latitude on the Atlantic coast, may approximately indicate the line of its northernmost winter residence."

Captain Blakistone's observations on the Turkey Vulture in British North America are as follows:—"A specimen was shot at Red-River Settlement on the 27th of April; observed at Fort Carlton near the forks of the Saskatchewan river in lat. 53° on May 7th, and again on the 7th of

September. I saw one feeding on a dead horse at the western base of the Rocky Mountains, a few miles south of where I determined the international boundary, 49th parallel. Again I saw many Vultures in the northern part of the State of Minnesota in the early part of the May following. Several specimens are in the Smithsonian Institution just from near the 49th parallel."

Common on the Rio Grande at Los Pinos, about 20 miles below Albuquerque (*Coues*); abundant at Fort Whipple, Arizona, but migrating in the latter part of October (*Coues*).

Dr. Brewer (*B. N. A.* iii. p. 345) completes the range of the bird in North America as follows:—"West of the Alleghanies it has a much less restricted distribution, from Central America almost to the Arctic regions, It is found more or less frequently in all the middle, the southern, western, and north-western States without an exception. It is met with in large numbers throughout the entire Pacific coast of North America, from Lower California to Washington territory.

Vancouver's Island (*Brown*).

Florida (*G. C. Taylor*). Matamoras, Texas (*Dresser*).

Bahama Islands (*Baird*).

Bermuda. Once in December (*Baird*).

Central America.

Mexico. Orizaba (*Botteri*). Very numerous in Western Mexico, and I found it as far south as Tehuantepec and in the Tres Marias (*Grayson*, cf. *Lawrence, Mem. Bost. Soc.* ii. p. 303).

Honduras. Common, usually seen in the outskirts of towns and in the villages (*G. C. Taylor*).

Guatemala. Not nearly so abundant as *Catharistes atratus*, frequenting the uncultivated and forest districts; a few may always be seen about the Lake of Dueñas (*Salvin*).

Costa Rica. Much rarer than *C. atratus*, and only found far from human habitations (*Von Frantzius, J. f. O.* 1869, p. 370).

Panama (*M'Clelland*).

West-India Islands.

Jamaica. The scavenger in towns and villages (*E. C. Taylor*).

Cuba. Resident (*Gundlach*).

N.B.—Dr. Gundlach discredits the occurrence of the species in Porto Rico (*Maugé*), and also in S. Domingo.

South America.

Columbia Ocaña (*Wyatt*).

Ecuador. I think it probable that the Turkey Vulture of these countries will prove to be the true *R. aura*; but I have not seen a specimen. Fraser obtained them at Puellaró, Pallatanga, and Babahoyo. It is to be noted

that he gives the colour of the legs as "yellow;" Audubon describes them as "flesh-coloured tinged with yellow."

Venezuela. Mr. E. C. Taylor does not notice any difference between the Turkey Vulture that he found to be "numerous on the Orinoco," and the one he observed in Jamaica.

Trinidad (*E. C. Taylor*). Whichever species the Venezuelan bird proves to be, the species will doubtless be the same from this island.

Chili. The Turkey Vulture, identical with North-American specimens, is found in Chili, and probably migrates along the chain of the Andes. Unfortunately we do not know whether it is resident or only a visitant to this country. Dr. Philippi speaks of it as being as common as *R. atratus,* but always found near the coast (*Cat. Mus. Sant.* p. 2); it is found in abundance along the coast of Chili, also in the interior (*Brydges*); Hasleyn Cove (May 1868), Halt Bay, and Messeur Channel (*Cunningham*).

La-Plata States. In the western and northern part of the La-Plata country—Mendoza, Catamarca, Tucuman (*Burmeister*).

19. Rhinogryphus perniger. (Map VI.)

Œnops perniger, *Sharpe, Cat. B.* i. p. 26.

In my 'Catalogue' I separated the Turkey Vulture of South America as a distinct species from that of North America. *R. perniger* I believe to be a small form *resident* in South America; but the range is at present entirely undecided. The British Museum has a specimen from the north side of the river Amazon, collected by Mr. Wallace; and I believe that another skin procured by Mr. H. Whitely at Arequipa, in Peru, is the same bird. It is doubtless the bird of which Burmeister speaks, under the name of *Catharistes aura*, as breeding in Brazil, where it is not found in the wood-region, but more in the Campos districts of inner Brazil; it is not nearly so common as *C. atratus*, and was not met with by him on his journey. It does not live in troops like the last named, but singly or in pairs, like the King Vulture. Azara found it in Paraguay. Natterer's localities are as follows:—

Forte do S. Joao, on the sea-shore (February); *Mattodentro* (December); *Ypanema* (April); *Sapitiba* (February); *Fachina Velha* (August); *Ytararé* (April); *Forte do Rio Branco* (February, April).

From what I have said, it will be seen that it is by no means easy to define the *species* or the *ranges* of the Turkey Buzzards; and a great deal more research and a larger number of specimens are required to solve the problem.

20. Rhinogryphus falklandicus. (Map. VI.)

Œnops falklandica, *Sharpe, Cat. B.* i. p. 27, pl. ii. fig. 1.

Hab. Falkland Islands, where it replaces the true *R. aura,* from which it is distinguished by the secondaries being grey externally.

21. Rhinogryphus urubitinga. (Map VII.)

Œnops urubitinga (*Pelz.*); *Sharpe, Cat. Afr. B.* i. p. 28, pl. 2. fig. 2.

Hab. Brazil (*Mus. Norw.*); Irisanga (S. Paulo), December; Sapitiba, February; Forte do Rio Branco, February, March, and April (*J. Natterer*). Chyavetas, E. Peru, "keeps to the forest in pairs, never approaching the towns and villages" (*E. Bartlett*). Surinam (*Mus. Brit.*). British Guiana, and less numerous than *Catharistes atratus*; found principally about the creeks of Mahaica and Mahaicony" (*Bonyan*).

N.B. This may also be the Yellow-headed Vulture noticed by Mr. Layard near Para (Ibis, 1873, p. 395).

22. Rhinogryphus californianus. (Map VII.)

Œnops californiana (*Shaw*); *Sharpe, Cat. B.* i. p. 28.

Hab. Pacific-coast region of North America, from the mouth of the Colorado to the Columbia, Southern Utah (*Henshaw*). Fort Yuma, Arizona (*Coues*; cf. *Ridgway, N.-A. Birds,* iii. p. 339; *Coues, B. N.W.* p. 384).

As in the case of the other North-American Vultures, I extract the range as given by Dr. Brewer in his great work on North-American Birds:—"This large Vulture, so far as is known, is restricted to the area on the Pacific coast from the Columbia river to the Colorado, and extending as far to the east as the Sierra Nevada. None are known to have been taken in Mexico; and it very rarely goes north of the Columbia. It is said to be most common in the hot interior valleys of California, where are large herds of cattle, upon which it to a large extent depends for its food. Dr. Cooper saw none on the Colorado, and met with none east of the San-Bernardino Mountains. Even at Fort Mohave the cattle killed during the five months he resided there did not attract one of these Vultures.

"Dr. Cooper did not see these birds in any number along the sea-coast, and has noticed none on the islands or in the highest Sierra Nevada. Yet they are said, when other food is scarce, to feed on dead seals and whales; but this fact he has never witnessed.

"Dr. Newbury states * * * after his party left the Sacramento Valley, he saw very few in the Klamath basin, and met with none within the limits of Oregon. It is occasionally found there, but much more rarely than in California."

EXPLANATION OF THE MAPS (PLATES I.–IX.).

Map I.

The range of *Vultur monachus* in the Old World is coloured *yellow*, the probable distribution of the species being coloured lighter.

In the New World the range of the Condors (*Sarcorhamphus gryphus* and allied species) is coloured *blue*.

Map II.

The Griffon Vulture's range is here coloured *yellow*, the probable extent of it being represented lighter. No distinction is made in the habitats of *G. fulvus*, *G. fulvescens*, &c., as their specific value is still *sub judice*; and therefore the map shows the distribution of the true Griffons.

The *blue* colour illustrates the range of the King Vulture (*Cathartes papa*).

Map III.

The South-African Griffon (*Gyps Kolbi*) inhabits the part of Africa coloured *yellow*; and its ally, the Himalayan Griffon (*Gyps himalayensis*), is found in the Himalayas and in Turkestan, in the country coloured *pink*.

In the New World the range of the Black Turkey-Vulture (*Catharistes atratus*) is coloured *blue*.

Map IV.

The range of Rüppell's Griffon (*Gyps Rueppelli*) is coloured *yellow*, and that of the Long-billed Griffon (*Gyps indicus*) *pink*, both being Old-world species.

Map V.

This map illustrates the range of the genus *Pseudogyps*,—the Bengal White-backed Griffon (*P. bengalensis*) being found in the country coloured *pink*, whilst the range of its African representative, the White-backed Griffon (*P. africanus*), is shown by the *yellow* colouring.

Map VI.

The range of the genus *Lophogyps* is here shown by its single species, *L. occipitalis*, found in Africa, as illustrated by the *yellow* colour.

The ordinary Turkey-Vulture of the New World (*Rhinogryphus aura*) is found in the countries coloured *green*; and the habitat of its South-American representative (*R. perniger*) will most likely be found to be in the part of the continent coloured *blue*, the Falkland-Islands Turkey-Vulture (*R. falklandicus*) being confined, as its name implies, to the Falklands (*pink*).

Map VII.

This shows the range of the genus *Otogyps*—that of the Indian Eared Vulture (*O. calvus*) being coloured *pink*, while its African ally is found in the districts coloured *yellow*, no distinction being made between the Nubian and South-African races.

In the New World is illustrated the range of the Californian Vulture (*green*); and that of the Yellow-headed Turkey-Vulture (*R. urubitinga*) is coloured *blue*.

Map VIII.

On this map is shown the range of the White Scavenger Vultures, *Neophron percnopterus* and *N. ginginianus*. That of the former is coloured *yellow*, and that of the Indian species *pink*; but it is difficult to say where the ranges of the two species coalesce.

Map IX.

In this map is illustrated the range of the Hooded Scavenger Vulture (*Neophron pileatus*), no distinction being drawn between the typical form and the smaller and more northern one, *N. monachus*, which I do not now believe to be of specific value (*yellow*).

On the Migration and Habits of the Norwegian Lemming. By W. Duppa Crotch, Esq., M.A., F.L.S.

[Read May 4, 1876.]

Although much has been written and constantly repeated, with reference to the habits and migrations of the Lemming, yet the obscurity which hangs alike over its permanent home and the motive of its journeys has never been completely dissipated; and I much fear that the present paper will rather suggest a new problem than prove a satisfactory solution of those already existing.

During ten consecutive summers spent in Norway I have three times lived literally in the midst of the lemmings, and have even, though involuntarily, shared my bed with them; thus I am enabled to speak positively, so far, at least, as my observation extends.

The species to which these remarks apply rejoices, unfortunately, in many an "alias;" but perhaps the name *Lemmus norvegicus* * will best suit the present purpose, especially as the native name for the animal is "Lemander." This mouse, or rather vole, since it belongs to the Arvicolæ, resembles in colour and form a diminutive Guinea-pig, and is extremely variable in its size and markings. It has long attracted the notice of writers, both on account of its sudden appearance and its pugnacious and indomitable disposition; and the early description, "Victitat betulæ nanæ amentis, lichene rangiferino et aliis, mordax, sibilat, hieme sub nive currit, singulis circiter decem annis, insigni gelu præsertim imminente, universus animalium exercitus, autumno, noctu præsertim linea recta migrat; pauca tamen in montes redeunt," has been usually followed and quoted, although, as will presently appear, it leaves much to be desired. Olaus Magnus thought that lemmings fell from the clouds, to which Ray rejoins, "mihi minime probatur," adding that anatomical investigation had convinced him that "nature had not been such a niggard of her gifts as to render such a method of generation necessary."

Pennant † says that the Norwegian lemmings, which are larger than the Russian species, descend from the Kolen, marching in parallel lines 3 feet apart; they traverse Nordland and Finmark, cross lakes and rivers, and gnaw through hay- and corn-stacks

* [Even more correctly *Myodes lemmus* (Linn.).—Ed.]

† Synop. of Quad. 1771, p. 271; Hist. Quad. 1793, p. 198.

rather than go round. They infect the ground, and the cattle perish which taste of the grass which they have touched: nothing stops them, neither fire, torrents, lakes, nor morasses. The greatest rock gives them but a slight check; they go round it, and then resume their march directly without the least division. If they meet a peasant, they persist in their course, and jump as high as his knees in defence of their progress. They are so fierce as to lay hold of a stick and suffer themselves to be swung about before they quit their hold. If struck, they turn about and bite, and will make a noise like a dog. Foxes, lynxes, and ermines follow them in great numbers; and at length they perish either through want of food or by destroying one another, or in some great water, or in the sea. They are the dread of the country; and in former times spiritual weapons were exerted against them: the priest exorcised them, and had a long form of prayer to arrest the evil. Happily it does not occur frequently, once or twice in twenty years. It seems like a vast colony of emigrants from a nation overstocked—a discharge of animals from the northern hive which once poured out its myriads of human beings upon Southern Europe. They do not form any magazine for winter provision; by which improvidence, it seems, they are compelled to make their summer migrations in certain years, urged by hunger. They are not poisonous, as vulgarly reported; for they are often eaten by the Laplanders, who compare their flesh to that of squirrels.

Here I must enter a protest; for having tasted many animals, I should prefer even the "cold missionary" of Sydney Smith to a lemming ragout. However, tastes differ. I once made a savoury mess of stewed ermines, and invited my Norwegian guide and friend to partake of it. He gently and politely said, "I *have* breakfasted," but immediately walked out and returned without that most necessary meal.

Prof. Newton *, writing on the migration of birds, distinguishes as "partial migrants" such species as the woodcock, of which only the *majority* of individuals migrate. The lemmings must belong to this class, since although none of their wandering hosts return, it must be assumed, even if it be difficult of proof, that some remain at home to supply material for future emigrants. While a deficiency of food explains the departure, it does not, as Prof. Newton rightly remarks, account for the return of those birds

* Encycl. Brit. 9th ed. (1875) vol. iii. p. 765.

which migrate south. There is, however, in birds, and, I believe in fish, a very strong affection for their old nests and breeding-places generally, which cannot exist in the lemmings, since they breed *en route.*

M. Guyon*, writing in 1863, disposes of the theory that these migrations are influenced by *approaching* severe weather, since the one witnessed by himself took place in the spring; also the superabundance of food during the previous autumn seemed evidence against the theory of starvation. He therefore adopts a third view, that excessive multiplication in certain years necessitates emigration, and that this follows a descending course like the mountain-streams, till at length the ocean is reached.

It is, however, very remarkable that no one professes to have seen the lemming at home; and as he is not shy, the broad fjelds of Norway are as conspicuous by his absence as by his too demonstrative presence.

I well remember, in the autumn of 1867, when I happened to be shooting at an elevation of about 4000 feet, that my attention was suddenly drawn to a shrill note, which I imagined to be produced by some bird unknown to me, till my Norsk companion told me it was the cry of a Lemander or lemming.

I had not long to search for the musician. He had set his back against a stone, and, repeatedly jerking his body up and down as though intending to jump at me, kept uttering the quick shrill yelp which first drew my attention. I made a hasty snatch at the pretty animal, whose black bead-like eyes protruded with rage. He also made a snatch; and his snatch proved the more successful of the two, as his incisor teeth left their pattern on my hand for some days afterwards.

My companion was no friend to the lemmings, and was loud in his prophecies as to a severe winter and diminished grass to follow in the spring. However, "one swallow does not make a summer," and it was some weeks before I saw another lemming; then, on lifting a large flat stone, I found six in a snug nest, apparently recently born. In a few days the whole fjeld became swarming with these pretty voles. My dogs waged incessant war upon them, although they never eat them; and I noticed that several species of hawks became unusually plentiful.

As the season advanced and snow covered the ground, footprints showed how foxes had joined in the pursuit, whose tracks were

* Comptes Rendus, 1863, p. 486; and Ann. & Mag. N. H. 3rd ser. xii. p. 407.

studded with dead lemmings, which they had killed but not eaten, probably having plenty of more delicate food. In the higher fjelds I noticed that the Reindeer had often killed the lemmings, apparently by stamping upon them, though I do not believe their bodies are ever eaten.

It was a curious sight, when the whole visible landscape was of a spotless whiteness, to see an apparently black form suddenly spring from the surface and scurry over the snow and again vanish. I found some of the holes where this feat was executed were at least 5 feet in depth; and when the snows of eight months had melted beneath perpetual daylight and almost perpetual sunshine, it became easy to trace the long lines formed in the grass by these improvident excursionists. I use the word improvident, because no stores were accumulated by them as by the common field-mouse; but yet this probably only necessitated foraging excursions whilst their congeners were lazily sleeping.

In this country we fail to conceive how much active life goes on beneath the snow; but in northern latitudes its warm protection serves as a roof to numerous birds, quadrupeds, and insects, who are thus enabled to find an otherwise impossible sustenance. It is only at the commencement of the winter that the footprints on the snow tell of the ceaseless struggles and surprises which render the long autumnal nights so fatal to all but predaceous animals.

It does not appear that the migration of the lemmings is ever completed in one year. In this case, and in all the others that I have noticed or heard of, the animals came during the summer. There was no "procession," no serried bands undeterred by obstacles; but there was a continuous invasion of temporary settlers, which reared their young two or three times in the summer, and, with reinforced numbers, spread even further westward. They certainly did not mine through hay- and corn-stacks, as those familiar objects are all but unknown in Norway.

On calm mornings my lake, which is a mile in width, was often thickly studded with swimming lemmings, every head pointing westward; but I observed that when the boat came near enough to frighten them, they would lose all idea of direction, and frequently swim back to the bank they had left. When the least wind ruffled the water, it was all over with the swimmers; and never did a frailer bark tempt a more treacherous sea, as the wind swept daily down the valley and wrecked all who were then afloat.

It was impossible not to feel pity for these self-haunted fugitives. A mere cloud rapidly passing over the sun affrighted them ; the approach of horse, cow, dog, or man alike roused their impotent anger ; and their little bodies were convulsively pressed against the never-failing stone of vantage whilst they uttered cries of rage. I collected five hundred skins with the idea of making a rug, but was surprised to find that a portion of the rump was nearly always denuded of hair ; and it was long before I discovered that this was caused by that habit of nervously backing up against a stone, to which I have already alluded. As this action is excited by so slight and constant a matter as the passage of the shadow of a cloud, I confess I am surprised not to find a natural callosity rather than so constant a lesion ; and this is a point which seems of some little importance in connexion with the whole subject of undoubtedly inherited tendencies, of which migration is an example.

Mr. Wallace * suggests that "the survival of the fittest" has played an important part in causing migration by giving an advantage to those animals which enlarge their breeding-area by travel. The lemming, it is true, always breeds during migration ; but if none return or survive, it is difficult to say what becomes of the fittest. However, I shall shortly have to mention a theory which may tide over the difficulty.

The lemmings certainly do not visit my part of Norway at any recurring period of years ; but every third or fourth year they may be expected with tolerable regularity, though in variable numbers. Thus it is quite probable that some migrations may have so far escaped notice as to give rise to the old idea that they took place every tenth year.

They are, however, always directed westwards ; and thus the theory that they are caused by deficiency of food fails so far, that these migrations do not take place in a southerly direction, by which a larger supply might be obtained. M. Guyon (*l. c.*) suggested that the course followed was merely that of the watershed. However, this runs east as well as west, and follows valleys which often run north and south for hundreds of miles, whereas the route pursued by the Lemming is due west. At all events this is the case in Norway, where they traverse the broadest lakes filled with water at an extremely low temperature, and cross alike the most rapid torrents and the deepest valleys.

With no guiding pillar of fire, they pass through a wilderness by night ; they rear their families on their journey ; and the three

* Nature, 1874, vol. x. p. 459.

or four generations of a brief subarctic summer serve to swell the pilgrim caravan. They winter beneath more than 6 feet of snow during seven or eight weary months; and with the first days of summer (for in these regions there is no spring) the migration is renewed. At length the harassed crowd, thinned by the unceasing attacks of the wolf, the fox, the dog, and even the reindeer, pursued by eagle, hawk, and owl, and never spared by man himself, yet still a vast multitude, plunges into the Atlantic Ocean on the first calm day, and perishes with its front still pointing westward. No faint heart lingers on the way; and no survivor returns to the mountains. Mr. R. Collett, a Norwegian naturalist, writes that in Nov. 1868 (quoted by Lilljeborg *infrà*) a ship sailed for 15 hours through a swarm of Lemmings, which extended as far over the Trondhjemsfiord as the eye could reach.

In this remarkable migration it is not perhaps the power of direction evinced which is most striking. Domesticated animals, and even men in a savage state, have often distinctly manifested this faculty, which, to whatever it may be owing, is certainly not explicable by any "known sense or power of judgment."

Herr Palmén*, indeed, says "experience guides migration," and the older migrants guide the younger, like one of Mr. Cook's "personally conducted tours." This cannot be true of the lemmings. I may briefly mention that a young dog which I took from England, and then from my home in Vaage Valley by a path to Heindaken, a distance of forty-six miles, ran back the next morning by a direct route of his own, crossing three rapid rivers and much snow, and accomplishing the distance in less than six hours without the vestige of a path. This same dog afterwards repeated the feat, but followed the path, and took two days in reaching his destination, hindered and not aided, as I believe, by his experience. But to return to the lemmings—it seems almost impossible that a so-called instinct, even if this could be shown to be independent of inherited experimental experience, would so totally and persistently fail in its only rational purpose. If insufficiency of food be alleged as the *present* cause of these migrations, the question at once arises, why do not settlers make a permanent home in the many oases through which they pass? Why, in fact, do they migrate westward and not southward? and why do they not return? The Swallows and all our familiar migratory birds seek

* Om Foglarnes flyttningsvägr (Helsingfors, 1874), an abstract of whose views is given by Prof. Newton, *op. cit.*

a more genial climate and more abundant food, but return to us as surely as summer itself; nor do they ever, so far as I know, breed during their passage. Even the Locusts present no such problem as the lemmings, since it is generally the wind rather than any migratory instinct which brings their dreaded hosts to the shores of Europe. Perhaps the most noticeable parallel is afforded by the migration of Pallas's Sand-grouse in 1863*, when a species, whose home is in the Tartar steppes, journeyed in considerable numbers to the most western shores of Europe, and very probably many individuals perished, like the lemmings, in the waves of the Atlantic.

There is, however, a solution of this difficulty, involving a subject that has always seemed to me of the deepest interest, and which led me to spend two years among the Canaries and adjacent islands. I allude to the island or continent of Atlantis.

Now without going so far as to assert that the Canary and other Atlantic groups are but the uppiled volcanic summits of a submerged land, it yet is evident that land did exist in the North Atlantic Ocean at no very distant date; and the depth of water on the so-called telegraph-plateau disposes of one of the difficulties felt by many with regard to more southern latitudes. Is it not then conceivable, and even probable, that when a great part of Europe was submerged and dry land connected Norway with Greenland, the Lemmings acquired the habit of migrating westward for the same reasons which govern more familiar migrations?

To make this clearer, let me put a hypothetical case. Suppose the Swallows were partial migrants from Great Britain, and suppose that Africa were to become submerged, would not many generations of Swallows still follow their inherited migratory instincts, and seek the land of their ancestors through the new waste of waters? whilst the remaining stock, unimpeded by competition, would soon recruit the ranks for a new exodus. It appears quite as likely that the impetus of migration towards this continent should be retained as that a dog should turn round before lying down on a rug, merely because his ancestors found it necessary thus to hollow out a couch in the long grass.

Influenced, I feel bound to admit, by this idea, I should willingly have found lemmings in Iceland; but the only indigenous mammal there, I believe, is the *Mus islandicus* (? *sylva-*

* *Vide* 'Ibis,' 1864, pp. 185–222.

ticus). I presume Mr. Andrew Murray* had been misled by insufficient description to suppose that this was a lemming from the American continent, from which he would have derived the comparatively recent connexion of Iceland and America. Indeed Steenstrup has shown that this theory, so far as it was supported by the identity of species, was quite untenable. In the absence of living specimens, I turned to fossil remains; but the so-called lemming of Brixham cave is stated to be *Lagomys spelæus*, which is more nearly allied to the hares. However, Professor Owen found a *Georychus*, which probably is the Siberian lemming, in company with remains of *Elephas primigenius* in lacustrine brick-earth near Salisbury. I am therefore inclined to assume that in former days the lemming had a climatal motive for its migrations; and it may even be supposed that some, at least, returned to their northern home; otherwise it seems hard to account for the persistency with which they cling to a suicidal routine.

One more point occurs to me before I conclude; and that is that I have been quite unable, although living very high up in the fjeld, to obtain any lemmings during the intervals of migration; nor can I throw any satisfactory light on their home, if it can be called by that name. Prof. Lilljeborg states† (as most Norwegians believe, but few or none have verified) that the lemming has its head quarters on the higher fjelds.

Finally, I feel that, whilst thus claiming this birthright of inherited tendencies for the lemming, I may be asked, "Why, then, has the singular fact of the raw and denuded back produced no inherited modification in the present race, since it is presumable that their enemies are not creations of yesterday?" Well, that I cannot answer; and one of my chief reasons for publishing this paper has been the hope that some one may be able to throw more light on the subject.

* Geograph. Distrib. of Mam. (1866) p. 26.

† Sveriges och Norges Ryggradsdjur, (1874) p. 374.

Trematode Parasites from the Dolphins of the Ganges, *Platanista gangetica* and *Orcella brevirostris*. By T. SPENCER COBBOLD, M.D., F.R.S., F.L.S., Correspondent of the Academy of Sciences of Philadelphia.

[Read May 4, 1876.]

[PLATE X.]

AN instructive coincidence in the pursuit of helminthology affords me the pleasure of bringing before the Society some noteworthy facts respecting two forms of fluke parasite*.

The special interest attaching to these insignificant creatures arises, in the first place, from the circumstance that they have been obtained from cetacean hosts that were not previously known to be liable to be infested by them. In the second place, both of the parasites have each only once before been seen by any observer; and in either case the original cetacean host is generically distinct from the hosts whence we have now obtained the parasites. Thirdly, the locality whence we have procured these entozoa is situated thousands of miles apart from either of the two regions in which the original specimens were discovered. Fourthly, the original localities yielding the specimens are themselves widely divergent from one another. Fifthly, and in either case, verification of the previously recorded facts has only been acquired after a lapse of many years. Lastly, our knowledge of the internal structure of both of the parasites, which was hitherto very limited, is now rendered tolerably complete, at least as regards the morphology and arrangement of all the more important internal organs.

For the possession of these parasites I stand indebted to Dr. John Anderson, F.L.S., Superintendent of the Indian Museum, Calcutta. I received them, with several others, on the 27th of September, 1875; and if I understand rightly, they together formed part of a much larger collection of entozoa, all of which have been secured by Dr. Anderson from hosts occupying the North-eastern Province of India. I may mention that the nematoid worms forming part of the contribution have already been described by me elsewhere; and, through the kindness of the donor, I am encouraged to look forward to the receipt of additional spe-

* In an Appendix to this paper I have also noticed a third species.

cimens, whose examination will in all likelihood yield interesting results.

The first trematode that I proceed to notice is the species termed *Distoma lancea* by the late C. M. Diesing. His description was based upon the examination of several parasites found by the Brazilian traveller Natterer. They were discovered in the biliary ducts of a male Dolphin dissected at Barra do Rio Negro on the 29th of December, 1833. Natterer calls this cetacean the Tacuschi, and in a letter to Diesing names the species *Delphinus tacuschi* in order to distinguish it from the *D. amazonicus* of Spix and Martius.

In all cases of parasitism it is desirable, when possible, to get accurate information as to the species of host infested. Accordingly I have sought Professor Flower's assistance; and he informs me that there are certainly two, if not three, species of Dolphin inhabiting the Amazons. In his paper in the 'Trans. Zool. Soc.' vol. vi. p. 87, he has shown that Spix and Martius's *D. amazonicus* is clearly referable to the Inia or Bolivian Dolphin (*Inia Geoffroyi*). Thus far the views of Flower, Natterer, and Diesing are in agreement; moreover the geographical position of Barra shows that the Dolphin in question could not be the Inia, since, as Blyth long ago remarked, this form "inhabits only the remote tributaries of the Amazon and the elevated lakes of Peru." Several other species from this river have been described, one of these being placed by Mr. Gray in a separate genus, and named by him *Steno tucuxi*. From the specific title there can, I think, be little doubt that Gray's cetacean answers to the *Delphinus tacuschi* of Natterer; but Professor Flower is of opinion that Gray's species is an ordinary *Delphinus*, in the sense in which that genus is now commonly restricted. In this case it may, he thinks, probably be referred either to the *D. fluviatilis* or to *D. pallidus*. Whichever view is correct, it is clear that Natterer's parasite was obtained from a thoroughly fluviatile cetacean, and not from an oceanic or even an estuary form.

From Diesing's original description, I am led to infer that Natterer had carefully examined several Dolphins, with negative results as regards the presence of flukes; at all events it is expressly stated that he found the *Distoma lancea* "once only," when numerous examples of the parasite were secured. Dr. Anderson's specimen was a solitary one, procured from the short-snouted Dolphin (*Orcella brevirostris*, Owen). He obtained it

on the 3rd of January, 1873. As it was removed from the duodenum, it might be expected to turn out a different species; probably it had escaped from the liver, the ducts of which may have contained others that evaded notice. Be that as it may, there can be no doubt as to the species, which is easily recognized by the fact that the body is irregularly serrated at its margin on either side below the ventral suckers. I know of no other trematode possessing these sinuosities. Dr. Anderson's parasite does not exhibit these irregular serrations so distinctly and sharply as the artist has represented them in Diesing's enlarged figures; but this may be due to the fact that the parasite is preserved in glycerine, which has certainly distorted the specimen. Without attempting any description of the anatomy of the worm, Diesing remarks that the internal organs may be seen through the transparent body. The uterine organs, crowded with ova and of a purple colour, are represented in his figures as forming a rather complicated rosette, branched after the fashion of a raceme. I have no doubt that the artist has been misled. He has represented its mode of termination above the ventral sucker quite correctly; but the uterine channel is not branched. I could not myself trace the passage towards its lower or ovarian end; but the upper uterine folds were few in number, broad, and simple in character. Diesing's figures give only obscure hints as to the situation of the remaining internal organs. Dr. Anderson's specimen showed two large irregularly oval testes placed one above the other in the middle line and rather higher up than is usual with those distomes that have the organs presenting this simple form. Its ducts were not visible. The yelk-forming glands are particularly well marked in Anderson's specimen, and consist of two laterally disposed masses, that on the left side reaching somewhat higher, whilst that on the right side extends correspondingly lower than its fellow. None of the vitelligene ducts were visible; but the so-called yelk-cells or capsules were well seen. The oval-shaped eggs were tolerably distinct and measurable, yielding a length of $\frac{1}{750}$ inch from pole to pole, by about $\frac{1}{900}$ inch in their transverse diameter. I could not get a clear view of the digestive canals; but, from the slight markings here and there noticeable, I feel tolerably sure that they conform to the ordinary unbranched type. I have represented their probable position and extent by a dotted outline. I saw no spines on the surface of the body; but the well-known tendency of these organs to fall off may have been the

cause of their apparent absence. As regards size, the shrivelled and shrunken character of the worm hardly permitted me to ascertain the length with accuracy. It did not, however, when unrolled, exceed one sixth of an inch at most, whereas some of Natterer's specimens measured up to half an inch in length. The neck of my specimen had also entirely lost that full and rounded character which Diesing has so well figured and called skittle-shaped (*kegelförmige*). The ventral sucker is very nearly twice as large as the oral sucker, the former measuring about the $\frac{1}{30}$ and the latter $\frac{1}{42}$ inch in diameter from side to side. Diesing represents the ventral sucker as perfectly circular; but in Anderson's specimen this organ is broadly oval, the transverse diameter being longer than the vertical. The central cup is somewhat less than $\frac{1}{100}$ inch in breadth.

The second trematode is one to which I am inclined to attach more importance, partly, no doubt, on account of the circumstance of its having been discovered by myself nearly twenty years since, but chiefly because the possession of many specimens has enabled me to acquire a much more accurate knowledge of its structure and affinities than that obtained in the case of *Distoma lancea*. In the 22nd volume of the Society's 'Transactions' I described a fluke of which I had secured numerous examples from the peripheral branches of the biliary ducts of a Porpoise (*Phocæna communis*). The cetacean was shot by Mr. Jardine Murray in the Firth of Forth in April 1855, and was regarded as a fine and healthy animal. I mention this because the bile-ducts were diseased in a similar way to that ordinarily observed in cases of rot affecting sheep, cattle, and other animals infested by flukes. In the original paper I did not perhaps lay sufficient stress upon the pathological facts that were observed by me at the time; but on referring to the manuscript notes still in my possession, I find it is stated that "the liver-ducts were in several places thickened and knotted near the surface of the organ. On opening these, they were were found to be loaded with small distomata." It is added that whilst the flukes were alive they displayed, under the microscope, a "double and peculiar intestinal tube," the skin also being clothed with spines which are arranged throughout with perfect regularity. Unfortunately the day on which Mr. Murray sent the Porpoise was a Saturday; consequently my dissections were hurried, and the specimens were placed in strong spirit, which immediately destroyed their transparency. I was further embar-

rassed, inasmuch as Mr. Murray had also kindly sent a large number of birds for dissection (Guillemots, Gulls, and a Parrot-beaked Awk) at the same time. I may yet further supplement the originally published record by stating that, when the ducts lying immediately below the surface of the liver were dissected out, they presented a distinctly beaded appearance, the successive enlargements of the lumen of the ducts being occupied by flukes closely packed together. At least twenty were found in one spot. As no figure of these abnormal ducts was published, I subjoin an outline which is an exact reproduction of a sketch I made in my note-book during the dissection. Unfortunately the actual thickness of the walls of the ducts was not represented; but, from recollection, I can state that it was considerable.

Outline of an abnormally enlarged biliary duct. Nat. size.

The most striking feature connected with the structure of the worm was the regularly twisted condition of the digestive canals. They presented, in short, a zigzag appearance, the lateral folds being so angular when seen in profile that they seemed to constitute, as it were, a transition between the ordinary simple tubes of a true *Distoma* and the branched intestinal tubes seen in *Fasciola*. In this view it was that I placed the worms in a distinct genus, for which I proposed the term *Campula*. I now think that there was no sufficient ground for this generic separation, since, although in all the flukes which I have examined from *Platanista* the characteristic zigzag appearance is present, yet I find no trace of any attempt at branching. In all Dr. Anderson's specimens obtained from the liver-ducts of the Gangetic Dol-

phin more or less decomposition of the contents of the intestinal tubes has occurred; consequently the angular appearance of the folds is entirely lost, the margins looking uniformly rounded in profile.

From the other characters of the worms I cannot bring myself to believe that these flukes from the Ganges are specifically different from those obtained from the Firth of Forth. Nevertheless, in order to make sure that I had not exaggerated the angular character of the intestinal folds as they appeared in my original specimens from the Porpoise, I recently broke up a preserved microscopic slide, and, after soaking the specimens in glycerine, succeeded in bringing the digestive organs well into view, when they displayed precisely the same degree of angulation as the original figure in the Society's 'Transactions' shows. There were, however, no traces of rudimentary diverticula, such as I fancied I saw, but did not actually describe, in the original specimens. I now believe that the deceptive appearances were due to the sharpness of the turns or coils of the tubes, which in rather opaque objects is very apt to mislead. This is especially the case with the uterine folds, which, as in the case of *Distoma lancea*, have been represented as branched when perfectly simple. From a recent examination of my dried specimens of *D. crassum* I do not feel quite sure that I have not myself fallen into this error. Be that as it may, I desire (on the supposition of an error of interpretation of the facts) to restore my *Campula oblonga* to the genus *Distoma*, and I shall therefore in future speak of this parasite as *D. campula*, retaining the generic as an appropriate specific title. By this change I do not think that the morphological significance of the folded digestive tube is by any means lost. As obtains in the spiral gut of sharks and rays, the object of folding can only be to gain a larger extent of intestinal capacity without incommoding the animal and thereby interfering with its ordinary manner of life. In the members of the genus *Fasciola* and also in the allied Planarians this requirement appears to obtain its maximum. Here, however, even the additional surface gained by a spiral extension of the intestinal tubes appears to be inadequate, since to meet the demand we find the two main channels branched in a most striking manner.

I cannot here treat of this part of the subject to the extent it deserves; but in relation to the question of transition-forms I may remark that an extreme degree of folding seems as if it must,

when pushed further, result in branching. This, I think, would happen should any departure from the central distome type be rendered necessary by the exigences of the creature. At all events, the spirally twisted and branched digestive organs constitute different ways in which nature attains one and the same end. I may add that this coiled condition of the tubes in *D. campula* is by no means unique, since I have seen it slightly developed in other trematode forms, and very conspicuously so in a species (*D. compactum*) which I procured from an Indian Ichneumon, described to this Society in 1859.

Turning to the other internal organs, I have to state that whilst the flukes from the Porpoise only showed that the vitelligene glands were well developed and that the reproductive outlets occupied the usual position, Dr. Anderson's specimens have furnished a good general view of all the reproductive organs. In particular they show that the single, relatively narrow, and unbranched uterine canal is of great length and coiled upon itself in a singularly tortuous manner. In this way the duct passes from side to side, crossing the central line of the body at least a dozen times, whilst every fold is likewise bent upon itself to such an extent as to increase its length to at least four times that of the animal. In short, the uterine folds may be pretty accurately described as passing in a regular manner from side to side, each separate coil being very much twisted upon itself, thus frequently forming secondary coils. In the fluke here drawn (Pl. X. fig. 2) I have accurately represented every winding of the duct from its vaginal outlet above to its termination, where it is joined by the ovarian and vitelligene ducts in the ordinary way. Only the merest traces of these smaller channels, however, were here and there visible; but the two oval testes are conspicuous and well defined, occupying a position somewhat lower than usual in the typical forms of fluke. There was a third organ, apparently the ovary. This was less well defined, and situated higher up in the middle line. The vitelligene glands occupied the usual position; but their precise limits could not be accurately fixed throughout. The terminal cells or capsules with their efferent ducts were well seen in several specimens. Lastly, the water-vascular system was constantly visible, or at least that part of the main channel which expands into a large vesicle immediately above the central point of the tail. At this part several of Dr. Anderson's specimens had given way entirely, the parenchyma of the body, and sometimes the testes, bursting

through. In all of them the caudal end thus exhibited a sort of tail as a mere result of *post mortem* changes. None of the Edinburgh specimens displayed the slightest trace of this projection or of the water-vessel connected with it.

The other points remaining to be noticed may be dismissed in a few words. The uterine duct was well filled with eggs, but it was nowhere abnormally distended. Approximately the ova gave a measurement of $\frac{1}{1000}$ of an inch from pole to pole by $\frac{1}{2100}$ inch in breadth. Although in Anderson's specimens the integumentary spines had fallen off, they were still attached in the original specimens from Edinburgh, and measured on the average $\frac{1}{500}$ of an inch in length. With their shafts directed downwards, they separately presented the form of a long cone, the base of which was only $\frac{1}{1000}''$ broad. Close to the apex each point of the spine curves gently upward. In connexion with the form of the parasite, I have only further to observe that the normal relative size and situation of the suckers is faithfully depicted from Anderson's specimens; but the tail end of the body is abnormally produced, from causes already referred to.

To conclude somewhat as I began, let me remark more fully upon the main points of interest suggested by these finds. So few in number are the students of helminthology that it need occasion no surprise if the internal parasites of cetaceans are little studied. Apart from what is stated in the writings of systematists (Rudolphi, Dujardin, Diesing, &c.), we have but few and scant notices of cetacean parasitism. The most important contribution is by Professor Van Beneden ('Les Cétacés, leurs Commensaux et leurs Parasites'). The Belgian helminthologist evidently desired to render his list of the parasites as complete as possible; nevertheless, extended as his record is, he neither notices *Campula oblonga* nor the remarkable cestode discovered at the same time. Mr. Murray's porpoise not only yielded numerous flukes, but it played the rôle of host to five large tape-worms (*Diphyllobothrum stemmacephalum*) and to multitudes of nematodes infesting the bronchi, the pulmonary vessels, and the heart (*Prosthecosacter inflexus* and *P. convolutus*). Other parasites were detected in the stomach; but I referred them to the partly digested fishes whose remains accompanied them. Van Beneden points to a paper by Lebeck describing a round worm from the stomach of a Gangetic Dolphin (*Ascaris delphini*). Dr. Anderson also found nematodes in the intestines of *Platanista*; but these correspond with

the *A. simplex* of Dujardin. On this head I will only add that cetaceans are evidently very much victimized by parasites, both by attacks from within and without; and it is clear that our knowledge of the species is exceedingly imperfect.

On *à priori* grounds it might be supposed that aberrant cetacean hosts would be likely to yield correspondingly aberrant parasitic types. This is not the case, however, either as regards the flukes and nematodes, or, indeed, as regards the cestodes, to any very marked extent. The explanation is not far to seek; for however divergent particular hosts may be, mere morphological changes in their organs will not of themselves materially alter the conditions of the parasite's existence. To be sure, in the case of the liver-infesting flukes, the mere size of the biliary ducts will tend to modify the size of the parasite; but it is incapable of altering the type. Thus the common liver-fluke attains very much smaller proportions in the hare and rabbit than it does in the donkey and ox; but the essential generic character seen in the branched intestine is strictly maintained. Again, the liver-fluke of the giraffe, if it in any degree coordinated with the aberrant characters of its host, would, we might presume, exhibit departures from the type still more marked. The facts, however, show that the only marked differences between the giraffe's *Fasciola* and the ordinary fluke refer to external configuration. Even the liver-fluke of the elephant (*F. Jacksoni*), the shape of which presents a striking contrast with that seen in the Ruminants, still displays the branched intestinal canals, and that, too, in such a manner as to suggest the closest alliance with the Planarians. As I have shown in my communication "On the Destruction of Elephants by Parasites" (The Veterinarian, 1875), the mud-swallowing habits of these huge hosts are eminently favourable to the introduction of fluke-larvæ; and it is worthy of remark that the intermediary bearers likely to be thus swallowed abound in just those very localities where Planarians have their head quarters.

If my argument is sound, it is clear that neither *Platanista* and *Orcella*, on the one hand, nor *Inia* and *Delphinus*, on the other, need be expected to yield fluke-parasites generically differing from those found in *Phocæna* and other cetacean types. Even wide differences of geographical distribution do not appear to exert any very marked change; and this is the more remarkable since such variations of habitat by the host might be expected not only to supply

new and peculiarly modified intermediary bearers, but also in other ways to alter materially the conditions of existence. Without a doubt some fluke-parasites are confined to particular localities; and this is solely due to the fact that their bearers and intermediary bearers are alike restricted to a limited territory. But for these restrictions, there is good reason to fear that (as in the case of *Bilharzia*, for example) several of the most terrible endemic disorders, now confined to limited areas, would become world-wide. Fortunately for them, the lower animals are much more capable of resisting the untoward effects of parasitism than ourselves. We, however, have the power of warding off most of the dangers from this source, since we are now in a position to adopt preventive measures. This is entriely due to the advance of helminthology. As regards domesticated animals, it may probably be said with truth that they suffer from entozoa more than wild ones. In the course of a large experience, however, I cannot say that I have found wild animals very much less infested. With the multiplication of beasts of burden and other serviceable quadrupeds there have also arisen greater facilities for infection; and if, as unfortunately seems to be the case, parasitism amongst domestic animals has increased rather than diminished, it is because those who possess the power to put a check upon these disorders have not thought it worth their while to obtain special information on this head.

As regards wild animals, it is well nigh impossible to acquire correct data as to the destructiveness of parasites. I have no hesitation in saying that half the amount of parasitism that I found in Mr. Murray's porpoise would have killed any ordinary domesticated animal. Our cattle and sheep are carried off by thousands by much less formidable lung-parasites than that cetacean harboured. Doubtless wild animals, cetaceans amongst them, becoming at length weakened by their parasitic guests, more readily succumb to their various other enemies, which, in the struggle for existence, are only too ready to reap the desired advantage. On the other hand, I have little doubt that the porpoises and seals that have died at the Zoological Gardens, and whose lungs were largely infested by parasites, would, in their natural haunts, have borne up against the evil effects of a much larger amount of parasitism than they were enabled to do in confinement. One conclusion, at all events, is inevitable, namely that endemics, epidemics, or epizootics of the parasitic kind, call them what we may, are for the most part

due to the excessive multiplication of particular helminths during certain seasons. As obtains in non-parasitic plagues of all sorts, there is a perpetual rise and fall in their prevalence; and this is simply due to the presence or absence, as the case may be, of favourable conditions. This is the general explanation of the irregularity observed in the periodical return and degree of virulence of the grouse-disease, which I hold to be due to parasites. The same explanation holds good in the case of the disorder I have termed *Olulaniasis* in cats, also in that of a nemato-helminthiasis affecting pigeons, due to *Ascaris maculosa*, also of a similar epizooty occasioned by the four-spined Strongyle (*S. tetracanthus*) infesting the horse, also of the well-known parasitic bronchitis caused by Strongyles in lambs and calves, also of a like disease occasioned by *S. commutatus* which sometimes carries off hares in great numbers. In short, this explanation applies to many other more or less clearly defined parasitic maladies. Flukes, generally speaking, are comparatively harmless. As a rule, and with some few and notable exceptions (*Bilharzia*, &c.), only such of them as occupy the liver are capable of doing serious harm to their bearers, whether wild or domesticated. That their presence in the liver of cetaceans is capable of setting up an unhealthy action is abundantly proved by the facts incidentally noticed in this paper. The whole subject of animal parasitism is one of increasing interest—zoologists, physiologists, and sanitarians being equally interested in its revelations. This consideration must serve as my excuse for noticing some of the practical points suggested by the study of these dolphin-trematodes.

Appendix.

Since the completion of this paper I received a letter from Dr. Anderson enclosing "a drawing of a parasite, enlarged 28 times, from the small intestine of *Platanista*." The drawing had been overlooked, but was fortunately found by Dr. Murie amongst some loose papers. Judging from the illustration (here reproduced), this is another distinct species of cetacean trematode, and at present new to science. When I received the specimen Dr. Anderson was making preparations to leave England; but in reply to my inquiries, he found time to inform me in a second letter that the host was a different individual from that which yielded *Distoma campula*. He obtained the new parasite in

March 1873. In this case there does not appear to have been more than one parasite present in the intestine. There is certainly something very peculiar about the head and neck of this fluke; but assuming that it was not in any way injured before the drawing was executed, I offer provisionally for its recognition the following nomenclature and characters.

Distoma Andersoni, n. sp. Body oblong, smooth externally, uniform in thickness, six times as long as broad; head with lateral projections; ventral sucker large and prominent; neck much constricted; tail evenly rounded off, blunt. Length $\frac{1}{8}''$, breadth about $\frac{1}{50}''$.

In addition to the above-mentioned characters, the drawing shows that the testes are globular and placed high up in the middle line of the body. The small lobed gland immediately above them is probably the ovary. The clear narrow line extending from the border of the lower testis to the end of the tail seems to mark the limit of the vitelligene organs on either side below. These glands in all likelihood extend upwards to the neck, being apparently very largely developed in this species.

EXPLANATION OF PLATE X.

Fig. 1. *Distoma lancea*, × 70 diameters.

2. *D. campula* (=*Campula oblonga*, Cobbold), × 50 diam. (The small letters refer to the same parts in these two different species.) *a*, oral sucker; *b*, ventral sucker; *c*, reproductive papilla; *d*, œsophageal bulb; *e*, œsophagus; *f*, intestinal tube; *g*, cæcal end of the same; *h*, testes; *i*, ovary; *k*, vitelligene gland; *l*, uterine canal; *m*, trunk of the water system.

3. *D. Andersoni*, × 28 diam. *a*, oral sucker; *b*, lateral prominence of the head; *c*, ventral sucker; *d*, neck; *e*, œsophageal bulb; *f f*, body; *g*, ovary; *h*, testes; *i*, central clear line; *k k*, vitelligene gland of one side; *l*, water-vascular outlet.

Notice of new living Crinoids belonging to the Apiocrinidæ. By Sir C. Wyville Thomson, LL.D., D.Sc., F.R.S., F.L.S., F.G.S., &c., Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff of the 'Challenger' Exploring Expedition.

[Read June 1, 1876.]

On the 25th of August, 1873, on our voyage from St. Vincent to Bahia, we sounded in 1850 fathoms with a bottom of "*Globigerina*-ooze," and a bottom-temperature of 1°·8 C., in lat. 1° 47′ N., long. 24° 26′ W., about 300 miles east of St. Paul's Rocks. The trawl was put over; and when recovered in the evening it yielded us an unusually large number of interesting forms:—with many others, several large specimens of a fine species of *Limopsis*; several Brachiopods; a small *Umbellularia*; some remarkable Bryozoa; several specimens of a large species of *Salenia*, differing apparently in other characters besides its much greater size from the widely distributed *S. varispina*; an entire specimen of a beautiful stalked Crinoid which I shall describe under the name of *Bathycrinus aldrichianus*; and some fragments of the stem of another Crinoid, *Hyocrinus bethellianus* *, of which we afterwards took one or two complete specimens and several fragmentary portions, at Station 147, lat. 46° 16′ S., long. 48° 27′ E., 30 miles to the westward of Hog Island, one of the Crozet group.

I now give a preliminary sketch of these two new Crinoidal forms, in the hope of preparing a detailed description of these and of the large number of undescribed *Pentacrini* which were among the most interesting of our captures, on my return.

I described and figured in the 'Depths of the Sea' (p. 452), under the name of *Bathycrinus gracilis*, a delicate little Crinoid which we dredged in the 'Porcupine' from a depth of 2475 fathoms to the south of Cape Clear. I think there can be little doubt, from the structure of the stem and calyx, and from the form and

* As the stalked Crinoids are perhaps the most remarkable of all the deep-sea groups, both on account of their extreme rarity and of the special interest of their palæontological relations, I mean to associate the names of those naval officers who have been chiefly concerned in carrying out the sounding, dredging, and trawling operations with the new species whose discovery is due to the patience and ability with which they have performed their task. Lieutenant Pelham Aldrich was first lieutenant of the 'Challenger' during the first two years of her commission; he is now with Captain Nares as first lieutenant of the 'Alert;' Lieutenant George R. Bethell, I am glad to say, we have still with us.

sculpture of the plates and joints, that the first named of the two species now to be noticed must be referred to the same genus. There is, however, one marked difference between the two: in our specimen of *B. gracilis*, which looks as if it were full-grown, the ten arms are perfectly simple, and there is no trace of pinnules, while in *B. aldrichianus* the pinnules are well developed.

As I have already said (*loc. cit.*), strong resemblances in the structure of the stem, in the structure of the base of the cup, and in the form and arrangement of the ultimate parts of the arms associate *Bathycrinus* with *Rhizocrinus*; but the differences between the two genera are very obvious. The radial axillary joints, which in *Rhizocrinus* are contracted to support a single first brachial, are here expanded and bear two articulating surfaces giving origin to two arms; so that, as in most Crinoids, the number of primary divisions of the arms is ten. The structure of the cup and of the upper part of the stem, while essentially the same in both, is different in detail: in *Rhizocrinus* the funnel-shaped piece formed by the coalescence of the basals with the fused first radials above and the dilated upper joint of the coalesced upper joints of the stem beneath, makes up a large part of the cup; while in *Bathycrinus* the stem barely enlarges at its junction with the cup, the ring formed by the basals is very small, and the first radials are free from the basals, and often free from one another. The oral plates, which are conspicuous in *Rhizocrinus*, are absent in *Bathycrinus*.

Hyocrinus is a totally different thing; but, as we shall see hereafter, it presents certain general resemblances and even certain special correspondences in structure which seem to associate it also with *Rhizocrinus*.

There seems little doubt that *Rhizocrinus* finds its nearest known ally in the chalk and tertiary *Bourguetticrinus*, and that it must be referred to the neighbourhood of the Apiocrinidæ. Were it not that *Bathycrinus* and *Hyocrinus* are so evidently related to *Rhizocrinus*, the characters of the Apiocrinidæ are so obscure in the two first-named genera that one would certainly have scarcely been inclined to associate them with that group.

They are both comparatively small forms; and although they do not show the peculiar tendency to irregularity in the number of their principal parts which we find in *Rhizocrinus*, their calyces are small in proportion to the size of the stem, so that there is still a comparatively excessive development of the vegetative system.

Fig. 1.

Bathycrinus aldrichianus, Wy. T. Three times the natural size.

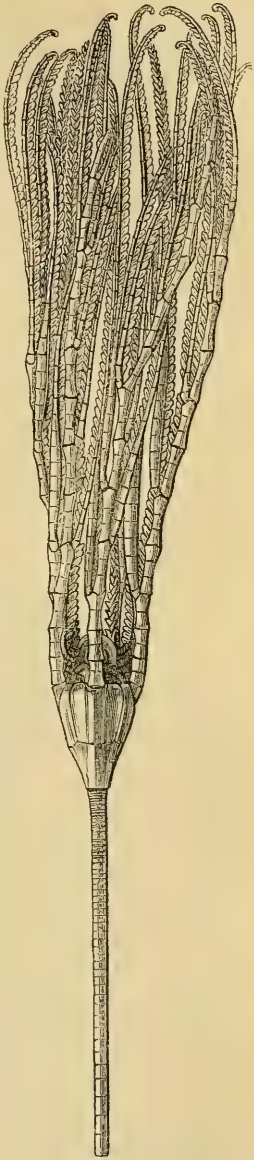
In *Bathhycrinus aldrichianus* (fig. 1) the stem is, in full-grown specimens, 200 to 250 millims. in length, and about 2 millims. in diameter across the enlarged articulating end of a joint. The longest stem-joints, from about the middle of the stem downwards, have a length of 4 millims.; and they rapidly shorten towards the base of the cup. They are dicebox-shaped, and have their ends bevelled off on different sides alternately, for the accommodation of masses of muscle. Towards the base of the stem, a few strong jointed branches come off and form a sort of imperfect root of attachment. The cup consists of a series of basals which are soldered together into a small ring, scarcely to be distinguished from the upper stem-joint. Alternating with these are five large triangular first radials: these are often free; but in old examples they also are frequently ankylosed into a funnel-shaped piece. The second radials are articulated to the first by a true joint with strong bands of contractile fibre; they are broad and flat, with an elevated vertical central ridge which is continued down upon the first radials (though in these it is not so marked), and lateral wing-like extensions which curve up at the edges and are thus slightly hollowed out vertically on each side of the central ridge. In the third radials or "radial axillaries," which are joined to the second by a syzygy, the upper border of the plate is nearly straight, but it is divided into two facets for the articulation of the first two brachials. The ridge is continued from the second radial to about the middle of the third, where it divides into two, and its branches pass to the insertions of the brachials to be continued along the middle line of the arms. The wing-like lateral processes are continued along the sides of the radial axillaries and along each side of at least the first three brachials. The arms are ten in number. In the larger specimens they are about 30 millims. in length, and consist of from forty to fifty joints. The first and second and the fourth and fifth brachials are united by syzygies; and after that syzygies occur sparingly and at irregular intervals along the arms. There are no pinnules on the six or seven proximal joints of the arms; but towards the distal end there are usually about twenty in two alternating rows; the number and amount of development of the pinnules seems to depend greatly upon age, and not to be very constant. The arms and the pinnules are deeply grooved within; and along the edges of the grooves are ranges of imbricated reniform plates, fenestrate and very delicate, much resembling those in the corresponding position in *Rhizocrinus*. The disk is

membranous, with scattered calcareous granules. The mouth is subcentral; there are no regular oral plates; but there seems to be a determination of calcareous matter to five interradial points round the mouth, where it forms little irregular calcareous bosses. There is an oral ring of long fringed tentacles; and the tentacles are long and well marked along the radial canals. The excretory opening is on a low interradial papilla. The ovaries are borne upon the six or eight proximal pinnules on each arm; they are short and rounded, resembling much in form those of *Antedon rosaceus*. *Bathycrinus* appears to possess an assemblage of characters in some respects intermediate between *Rhizocrinus* and the pentacrinoid stage of *Antedon*. I reserve a full discussion of its systematic position until I have an opportunity of describing it more in detail. It seems to be widely distributed; we have detected fragments of it at at least six or seven stations in the Atlantic and the Southern Sea.

Hyocrinus bethellianus (fig. 2) has much the appearance, and in some prominent particulars it seems to have very much the structure, of the palæozoic genus *Platycrinus*, or its subgenus *Dichocrinus*.

The longest portion of the stem which we dredged was about 170 millims. in length; but the basal part was wanting, and we have no means of ascertaining what may have been its means of attachment. The stem is much more rigid than that of *Bathycrinus*, and is made up of cylindrical

Fig. 2.

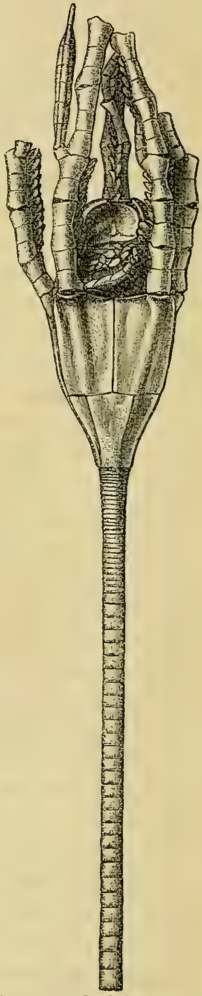


Hyocrinus bethellianus, Wy. T.
About twice the natural size.

joints, which are united to one another by a close syzygial suture, the applied surfaces being marked with a pattern of radiating grooves and ridges like those of so many of the fossil genera, and like those of the recent *Pentacrini*. The joints become short and very numerous towards the base of the cup.

The head, including the calyx and the arms, is 60 millims. in length. The cup consists of two tiers of plates only (fig. 3); the lower of these, which must be regarded as a ring of basals, is formed as in some of the Platycrinidæ, of two or three pieces: it is difficult to make out which with certainty; for the pieces are more or less fused, and the junctions in the mature animal are somewhat obscure. The second tier consists of five radials, which are thin, broad, and spade-shaped, with a slight blunt ridge running up the centre and ending in a narrow articulating surface for an almost cylindrical first brachial. The arms are five in number, they consist of long cylindrical joints deeply grooved within, and intersected by syzygial junctions. The first three joints in each arm consist each of two parts separated by a syzygy; the third joint bears at its distal end an articulating facet from which a pinnule springs. The fourth arm-joint is intersected by two syzygies, and thus consists of three parts; and so do all the succeeding joints; and each joint gives off a pinnule from its distal end, the pinnules arising from either side of the arm alternately. The proximal pinnules are very long, running on nearly to the end of the arm; and the succeeding pinnules are gradually shorter, all of them, however, running out nearly to the end of the arm, so that distally the ends of the five arms and the ends of all the pinnules meet nearly on a level. This is an arrangement hitherto entirely unknown in recent Crinoids, although we have something very close to it in some species

Fig. 3.



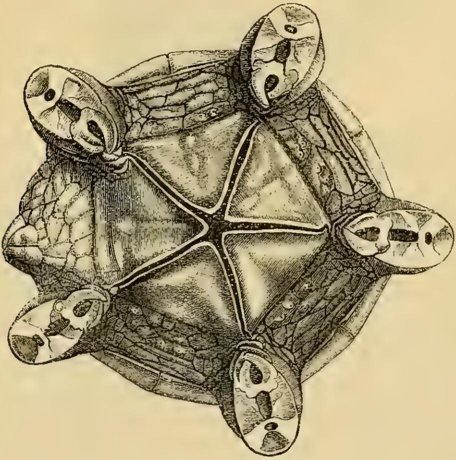
Hyocrinus bethellianus, Wy. T.
About four times the natural size. Station 147.

of the palæozoic genera *Poteriocrinus* and *Cyathocrinus*; here, I believe, however, the resemblance between *Hyocrinus* and the early fossil forms ends.

The arms and pinnules are deeply grooved within; and the grooves are bordered on either side by lines of imbricated, close-set, reniform, fenestrated plates, closely resembling those of *Rhizocrinus* and *Bathycrinus*.

The peripheral part of the disk is paved with plates irregular in form and closely set (fig. 4); round the mouth there are five very strong and definitely shaped valves, slightly cupped above and marked beneath with deep impressions for the insertion of muscles. The valves are pointed, and close over the mouth, forming a very perfect five-sided pyramid. The anal opening is on a short plated interradial tube.

Fig. 4.

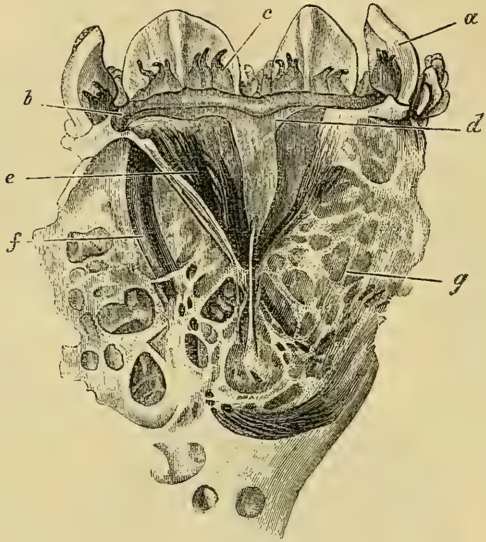


Disk of *Hyocrinus bethellianus*, Wy. T. Eight times the natural size.

The mouth opens into a short slightly constricted œsophagus, which is succeeded by a dilatation surrounded by brown glandular ridges (fig. 5, *d*, *e*). The intestine is very short, and contracts rapidly to a small diameter (*f*); the whole alimentary tract forms a single simple loop. Round the œsophagus a somewhat ill-defined vascular ring (*b*), which may possibly be continuous with the body-cavity, gives off opposite each of the oral plates a group of four tubular tentacles (*c*); and lines of similar tentacles of smaller

size fringe the radial grooves and the grooves of the arms and pinnules. The ovaries are very long and narrow, extending three fourths of the length of the first three or four pinnules on each arm.

Fig. 5.



Arrangement of the soft parts in *Hyocrinus bethellianus*. *a*, oral valves; *b*, oral vascular ring; *c*, oral tentacles; *d*, *e*, inner aspect of the œsophagus and stomach; *f*, intestine; *g*, loose areolated connective tissue. Eight times the natural size.

The assemblage of characters connected with the disk and soft parts thus shows a considerable resemblance between *Hyocrinus* and *Rhizocrinus*. My strong impression is that the mode of nutrition of the Cyathocrinidæ, and consequently the structure and arrangement of their disk, was essentially different from that of all the yet known living forms; and I think it probable that when we have an opportunity of studying the structure of *Hyocrinus* carefully, we shall find that its striking resemblance to *Platycrinus* is in a great degree superficial.

The following are, I believe, all the Crinoids, referable to the Apiocrinidæ, which we have hitherto met with during our deep-sea explorations:—

Rhizocrinus lofotensis, Sars.
Bathycrinus aldrichianus, sp. n.
B. gracilis, sp. n.

Hyocrinus bethellianus, sp. n.
H. bethellianus?

The last is a beautiful little thing which we dredged from a depth of 2325 fathoms at Station 223, lat. 5° 31′ N., long. 145° 13′ E., in the east Pacific, with a bottom of *Globigerina*-ooze, and a bottom-temperature of 1°·2 C. It certainly is in many respects very unlike the adult *H. bethellianus*; but it may possibly turn out to be the young of that species. There was only one specimen.

It has been found impossible, or at all events too dangerous, to examine and compare the species belonging to the Pentacrinidæ on board; many of the specimens are very large, and they are very tender, requiring the utmost delicacy in handling; it has therefore been thought in most cases advisable to pack them away in safety at once, and to defer their discrimination until our return home.

'Challenger,' South Atlantic,
March 5th, 1876.

Notice of some Peculiarities in the Mode of Propagation of certain Echinoderms of the Southern Sea. By Sir C. Wyville Thomson, LL.D., D.Sc., F.R.S., F.L.S., F.G.S., &c., Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff of the 'Challenger' Exploring Expedition.

[Read June 1, 1876.]

The very remarkable mode of reproduction of certain members of all the recent classes of Echinodermata by the intervention of a free-swimming bilaterally symmetrical "pseudembryo" developed directly from the "morula," from which the true young is subsequently produced by a process of internal budding or rearrangement, has long been well known through the labours of a host of observers headed and represented by the late illustrious Professor Johannes Müller of Berlin.

At the same time it has all along been fully recognized that reproduction through the medium of a "pseudembryo" is not the only method observed in the class, but that in several of the Echinoderm orders, while in a certain species a wonderfully perfect and independent bilateral locomotive zooid may be produced, in very nearly allied species the young Echinoderm may be developed im-

mediately from the segmented yelk without the formation of a "pseudembryo," or at all events with no further indication of its presence than certain obscure temporary processes attached to the embryo, to which I have elsewhere (Phil. Trans. for 1865, p. 517) given the name of "pseudembryonic appendages."

I have not at present an opportunity of consulting authorities; but if I may trust my memory, this direct mode of development has been described in *Holothuria tremula* by MM. Koren and Danielssen, in *Synaptula vivipara* by Professor Oersted, in a "viviparous sea-urchin" by Professor Grube, in *Echinaster* and in *Pteraster* by Professor Sars, in *Asteracanthion* by Professor Sars, Professor Agassiz, Dr. Busch and myself, in *Ophiolepis squamata* by Professor Max Schultze, and in "a viviparous ophiurid" by Professor Krohn. No less than four of these observations were made on the coast of Scandinavia. In temperate regions, where the economy of the Echinoderms has been under the eye of a greater number of observers, the development of the free-swimming larva appeared to be so entirely the rule that it is usually described as the normal habit of the class; while, on the other hand, direct development seemed to be most exceptional. I was therefore greatly surprised to find that in the southern and subarctic seas a large proportion of the Echinoderms of all orders, with the exception perhaps of the Crinoids (with regard to which we have no observations), develop their young after a fashion which precludes the possibility, while it nullifies the object, of a pseudembryonic perambulator, and that in these high southern latitudes the formation of such a locomotive zooid is apparently the exception.

This modification of the reproductive process consists in all cases, as it does likewise in those few instances in which direct development has already been described, of a device by which the young are reared within or upon the body of the parent, and are retained in a kind of commensal connexion with her until they are sufficiently grown to fend for themselves. The receptacle, in cases where a special receptacle exists in which the young are reared, has been called a "marsupium" (Sars), a term appropriately borrowed from the analogous arrangement in their neighbours the aplacental mammals of Australia. The young do not appear to have in any case an organic connexion with the parent; the impregnated egg from the time of its reaching the "morula" stage is entirely free; the embryos are indebted to the mother for pro-

tection, and for nutrition only indirectly through the mucus exuded from the surface of her perisom, and through the currents of freshly aerated water containing organic matter brought to them or driven over them by the action of her cilia.

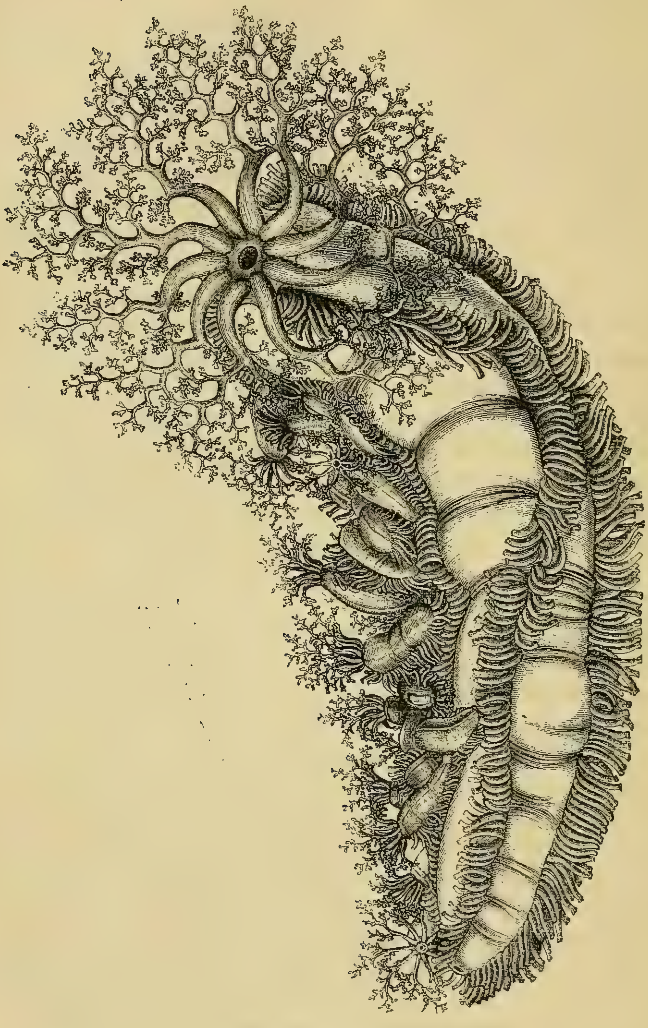
Animals hatching their eggs in this way ought certainly to give the best possible opportunities for studying the early stages in the development of their young. Unfortunately, however, this is a kind of investigation which requires time and stillness and passable comfort; and such are not the usual conditions of a voyage in the Antarctic sea. Specimens have been carefully preserved with the young in all stages; and I hope that a careful examination of these may yield some further results.

Although the principle and the leading features of the process are the same in all, the details vary greatly in the different groups. My present object is to give a preliminary sketch of some of the more remarkable modifications. In the absence of a sufficient supply of books of reference, I cannot vouch for the accuracy of specific determinations; the names which I have given to the species referred to must therefore be taken in some cases as provisional. I will select examples from the leading groups in order.

I. Holothuroidea pedata.

Cladodactyla crocea, Lesson, sp. (fig. 1). An elegant cucumber-shaped sea-slug, from 80 to 100 millims. in length, by 30 millims. in diameter at the widest part, of a bright saffron-yellow colour, very abundant, adhering to the vast fronds of *Macrocystis* in from five to ten fathoms water in Stanley Harbour at East Falkland Island. The mouth and arms are terminal; ten long delicate branched oral tentacles, more resembling in form and attitude those of *Ocnus* than those of the typical *Cucumariæ*, surround the mouth: the perisom is thin and semitransparent; and the muscular bands, the radial vessels, and even the internal viscera can be plainly seen through it. The three anterior ambulacral vessels are approximated; and on these the tentacular feet are numerous and well developed, with a sucking-disk supported by a round, cribriform, calcareous plate, or more frequently by several wedge-shaped radiating plates arranged in the form of a rosette; and these three ambulacra form together, at all events in the female, a special ambulatory surface. The two ambulacral vessels of the bivium are also approximated along the back; and thus the two inter-ambulacral spaces on the sides of the animal, between the external

Fig. 1.



Cladodactyla crocea, Lesson.

Natural size.

trivial ambulacra and the ambulacra of the bivium, are considerably wider than the other three; consequently, in a transverse section, the ambulacral vessels do not correspond with the angles of a regular pentagon, but with those of an irregular figure in which three angles are approximated beneath and two above. In the female the tentacular parts of the dorsal (bivial) ambulacra are very short; they are provided with sucking-disks; but the calcareous support of the suckers is very rudimentary, and the tubular processes are not apparently fitted for locomotion. In the males there is not so great a difference in character between the ambulacra of the trivium and those of the bivium; but the tentacles of the latter seem to be less fully developed in both sexes, and I have never happened to see an individual of either sex progressing upon, or adhering by, the water-feet of the dorsal canals.

In a very large proportion of the females which I examined, young were closely packed in two continuous fringes, adhering to the water-feet of the dorsal ambulacra (fig. 1). The young were in all the later stages of growth, and of all sizes from 5 up to 40 millims. in length; but all the young attached to one female appeared to be nearly of the same age and size. Some of the mothers with older families had a most grotesque appearance—their bodies entirely hidden by the couple of rows, of a dozen or so each, of yellow vesicles like ripe yellow plums ranged along their backs, each surmounted by its expanded crown of oral tentacles; in the figure the young are represented as about half-grown. All the young I examined were miniatures of their parents; the only marked difference was that in the young the ambulacra of the bivium were quite rudimentary, they were externally represented only by bands of a somewhat darker orange than the rest of the surface, and by lines of low papillæ in the young of larger growth; the radial vessels could be well seen through the transparent body-wall; the young attached themselves by the tentacular feet of the trivial ambulacra, which are early and fully developed.

We were too late at the Falklands (January 23) to see the process of the attachment of the young in their nursery, even if we could have arranged to keep specimens alive under observation. There can be little doubt that, according to the analogy of the class, the eggs are impregnated either in the ovarial tube or immediately after their extrusion, that the first developmental

Fig. 2.

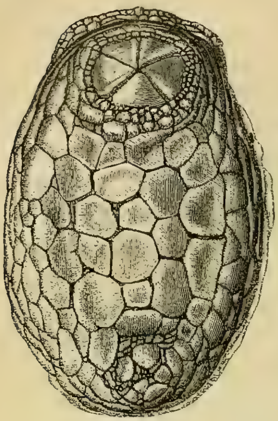


Fig. 2. *Psolus ephippifer*, Wy. Thomson.

About three times the natural size.

Fig. 3.

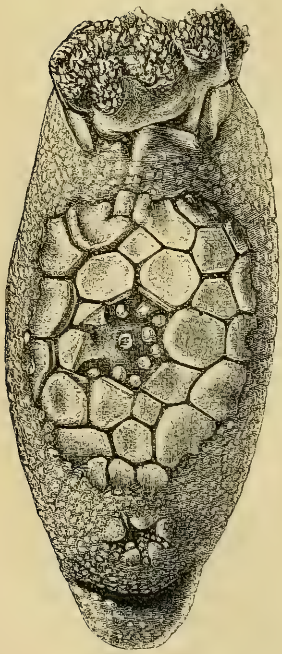


Fig. 3. *Psolus ephippifer*, Wy. Thomson.

About three times the natural size.

stages are run through rapidly, and that the young are passed back from the ovarial opening, which is at the side of the mouth, along the dorsal ambulacra, and arranged in their places by the automatic action of the ambulacral tentacles themselves.

This is one of the cases in which there is no special marsupium formed; it is possible that the comparatively genial conditions of the land-locked fiords and harbours of the Malvinas, and the additional shelter yielded by the imbricating fronds of *Macrocystis*, may render such exceptional provision unnecessary.

On the morning of the 7th of February, 1875, we dredged at a depth of 75 fathoms, at the entrance of Corinthian Harbour (*alias* "Whiskey Bay") in Heard Island (so far as I am aware the most desolate spot on God's earth), a number of specimens of a pretty little *Psolus*, which I shall here call for the sake of convenience *P. ephippifer*, although it may very possibly turn out to be a variety of the northern *P. operculatus*.

P. ephippifer (figs. 2, 3) is a small species, about 40 millims. in length by 15 to 18 millims. in extreme width. In accordance with the characters of the genus, the ambulatory area is abruptly defined, and tentacular feet are absent on the upper surface of the body, which is covered with a thick leathery membrane in which calcareous scales of irregular form are imbedded. The oral and excretory openings are on the upper surface, a little behind the anterior border of the ambulatory tract, and a little in advance of the posterior extremity of the body, respectively. A slightly elevated pyramid of five very accurately fitting calcareous valves closes over the oral aperture and the ring of oral tentacles; and a less regular valvular arrangement covers the vent.

In the middle of the back in the female there is a well-defined saddle-like elevation formed of large tessellated plates somewhat irregular in form, with the surfaces smoothly granulated (fig. 2). On removing one or two of the central plates we find that they are not, like the other plates of the perisom, imbedded partially or almost completely in the skin, but that they are raised up on a central column like a mushroom or a card-table, expanding above to the form of the exposed portion of the plate, contracting to a stem or neck, and then expanding again into an irregular foot, which is imbedded in the soft tissue of the perisom; the consequence of this arrnagement is that when the plates are fitted together edge to edge, cloister-like spaces are left between their supporting columns. In these spaces the eggs are hatched, and the eggs or the

young in their early stages are exposed by removing the plates (fig. 3). At first, when there are only morules or very young embryos in the crypts, the marsupium is barely raised above the general surface of the perisom, and the plates of the marsupium fit accurately to one another; but as the embryos increase in size, the marsupium projects more and more, and at length the joints between the plates begin to open (fig. 2), and finally they open sufficiently to allow the escape of the young. The young in one marsupium seem to be all nearly of an age. In *P. ephippifer* the marsupium occupies the greater part of the dorsal surface, and its passages run close up to the edge of the mouth, so that the eggs pass into them at once from the ovarial opening without exposure.

In the male there is, of course, no regular marsupium; but the plates are arranged in the middle of the back somewhat as they are in the female, except that they are not raised upon peduncles, so that it is not easy at once to distinguish a male from an infecund female.

Although we have taken species of *Psolus* sometimes in great abundance in various parts of the world, particularly in high latitudes, southern and northern, I have never observed this peculiar form of the reproductive process except on this one occasion.

II. Echinoidea desmosticha.

Among the marine animals which we dredged from the steam-pinnace on the 19th of January, 1874, at depths of from 50 to 70 fathoms in Balfour Bay (a fine recess of one of the many channels which separate the forelands and islands at the head of Royal Sound, Kerguelen Land), there were several examples of a small *Cidaris*, which I will name provisionally *C. nutrix*. As, however, in the case of *Psolus ephippifer*, I do not feel by any means certain that this is a distinct species. It comes certainly very near to some of the smaller varieties of *C. papillata*; but as it presents differences which serve at once to distinguish it, and as its peculiar mode of reproduction may perhaps be regarded as in itself a character of specific value, I give it in the mean time the benefit of the doubt.

C. nutrix (fig. 4) resembles *C. papillata* in the general form and arrangement of the plates of the corona, in the form and arrangement of the primary tubercles of the interambulacral areas and of the secondary tubercles over the general surface of the test, in the form of the plates of the apical disk and of the im-

bricated calcareous scales of the peristome, in the form, sculpture, and proportionate length of the primary spines, and in the form of the different elements of the jaw-pyramid and in that of the teeth; but the test is more depressed, the secondary spines which articulate to the ambulacral plates and cover the pore-areas are longer and more cylindrical, not so much flattened as they are in *C. papillata*; the large tulip-like pedicellariæ and the long thin tridactyle pedicellariæ mixed with the secondary spines in the northern species are wanting, or in very small number; and the minute pedicellariæ of the peristome are much fewer. The ovaries, which in *C. papillata* have the walls loaded with large expanded calcareous plates, contain only a few small branched

Fig. 4.

Cidaris nutrix, Wyv. Thomson.

spicules; and the calcareous bodies in the wall of the intestine are small and distant. The perforations in the ovarial plates in the female are somewhat larger than in *C. papillata*; and the ripe ova in the ovary appear to be considerably larger.

The eggs, after escaping from the ovary, are passed along on the surface of the test towards the mouth; and the smaller slightly spathulate primary spines which are articulated to about the first three rows of tubercles round the peristome, are bent inwards over the mouth, so as to form a kind of open tent in which the young are developed directly from the egg without undergoing any metamorphosis; until they have attained a diameter of about 2·5 millims., they are entirely covered with plates, and are provided with spines exceeding in length the diameter of the test. Even before they have attained this size and development, the more mature or more active of a brood may be seen straying away beyond the limits of the "nursery," and creeping with the aid of their first few pairs of tentacular feet out upon the long spines of their mother; I have frequently watched them return again after a short ramble into the "marsupium."

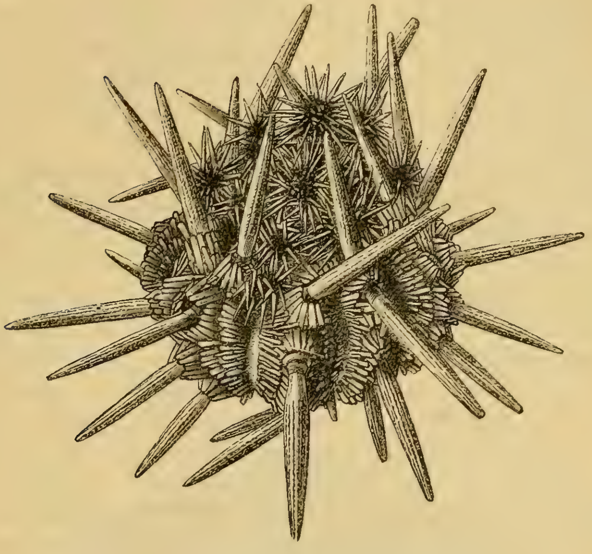
I am not aware that a free pseudembryo, or "pluteus," has been observed in any species of the restricted family Cidaridæ; but I feel very certain that *Cidaris papillata* in the northern hemisphere, except possibly in the extreme north, has no marsupial arrangement such as we find in the Kerguelen *Cidaris*. There have passed through my hands during the last few years hundreds of specimens of the normal northern form, of the Mediterranean varieties, *C. hystrix* and *C. affinis* (*stokesii*), and of the American *C. abyssicola*, from wide-spread localities and of all ages; and I have never found the young except singly, and never in any way specially associated with breeding individuals.

The genus *Goniocidaris* (Desor) seems to differ from the genus *Cidaris* in little else than in having a very marked, naked, zigzag, vertical groove between the two rows of plates of each interambulacral area, and one somewhat less distinct between the ranges of ambulacral plates. It includes about half a dozen species, which appear to be mainly confined to the colder regions of the southern hemisphere, although two of the species extend as far to the northward as the East Indies and Natal.

On the 28th of January, 1876, we dredged from the steam-pinnace, in about 10 fathoms water, off Cape Pembroke, at the en-

trance of Port William, East Falkland Island, a number of specimens of a pretty little species, *Goniocidaris canaliculata*, A. Agassiz (fig. 5). This species has a general resemblance, at a first glance, to *Cidaris papillata*, var. *stokesii*; but the radioles are

Fig. 5.



Goniocidaris canaliculata, Agassiz. Twice the natural size.

thinner and much shorter, and differ wholly in their sculpture; the shell is even more depressed; the secondary tubercles are more distant; and a very regular series of short club-shaped rays seated on miliary granules are interposed in the rows between the spines of the second order. The ovarial openings are extremely minute, and are placed close to the outer edge of the ovarial plates. The upper part of the test is quite flat, the flat space including not only the ovarial plates and the plates of the periproct, but the first pair, at least, of plates of each interambulacral area. Articulated to the primary tubercles of these latter are two circles of radioles, the inner more slender and shorter, the outer stouter and longer, but both series much larger than radioles usually are in that position on the test.

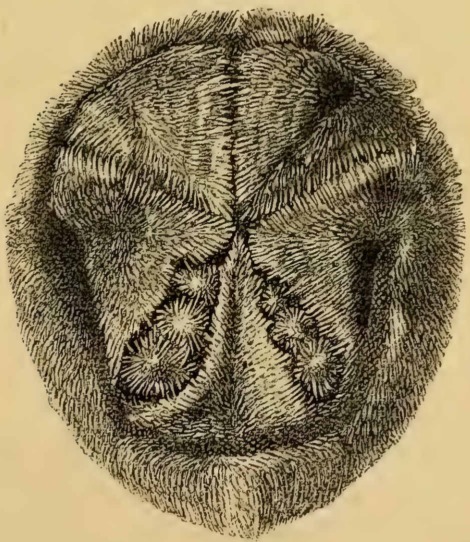
These special spines are cylindrical and nearly smooth, and they lean over towards the anal opening, and form an open tent for the protection of the young, as in *Cidaris nutrix*, but at the opposite pole of the body. In this species the eggs are extruded directly into the marsupium; and I imagine, from the very small size of the ovarial openings, that when they enter it, they are very minute, and probably unimpregnated. In the examples which we dredged at the Falkland Islands, the young were, in almost every case, nearly ready to leave the marsupium; we were too late in the season to see the earlier stages. The young in the same marsupium are nearly all of an age, some somewhat more advanced than others. The diameter of the test is from 1 to 1·5 millim., and the height about ·8 millim.; the length of the primary spines is, in the most backward of a brood, ·5 millim., while in the most advanced it equals the diameter of the test. The perisome, in which the cribriform rudiments of the plates of the corona and the young spines are being developed, is loaded with dark purple pigment, which makes it difficult to observe the growth of the calcareous elements. About thirty primary spines arise on the surface of the corona almost simultaneously in ten rows of three each: they first make their appearance as small papillæ covered with a densely pigmented ciliated membrane; and when they have once begun to lengthen, they run out very rapidly until they bear to the young nearly the same proportions which the full-grown spines bear to the mature corona. Very shortly some of the secondary spines, at first nearly as large as the sprouting primary spines, make their appearance in the interstices between these; and a crowd of very small spines rise on the nascent scales of the peristome. Successively five or six pedicellariæ are developed towards the outer edge of the apical area, which at this stage is disproportionately large; the pedicellariæ commence as purple papillæ, which are at first undistinguishable from young primary spines; the first set look enormously large in proportion to the other appendages of the perisome. Almost simultaneously with the first appearance of the primary spines, ten tentacular feet, apparently the first pairs on each ambulacrum of the corona just beyond the edge of the peristome, come into play; they are very delicate and extremely extensile, with well-defined sucking-disks; and with these the young cling to and move over the spines of the mother, and cling to the sides of the glass vessel, if they

are dislodged from the marsupium. This species seems to acquire its full size during a single season. We dredged it at the close of the breeding-season, and we took no specimens intermediate in size between the adult and the young.

III. Echinoidea petalosticha.

In shallow water, varying from 20 to 50 fathoms, with a muddy bottom, in Accessible Bay, Kerguelen's Land, we dredged on the 9th of January, 1874, from the steam-pinnace, innumerable Urchins very much resembling in general appearance *Brissopsis lyrifera*, the common Fiddle Urchin of the boreal province of the British seas. The group to which these Urchins belong requires careful revision; but it seems, from the absence of the subanal fasciole and from some other characters, that the species at present under consideration must be referred to the genus *Hemiaster*; and it is very probable, from its great abundance in ordinarily accessible depths, that it will turn out, on comparison, to be one of the species brought home by Sir James Clark Ross's Antarctic Expedition.

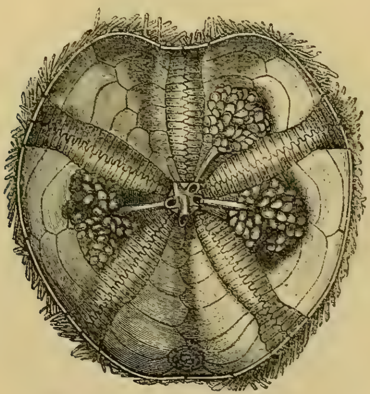
Fig. 6.



Hemiaster, sp. Twice the natural size.

The test of a full-sized example (fig. 6) is about 45 millims. in length and 40 millims. in width; the height of the shell in the female is 25 millims., in the male it is considerably less. The apex is nearly in the centre of the dorsal surface; the genital openings are three in number, in the female very large; the bilabiate mouth is placed well forward on the ventral aspect; and the excretory opening is posterior and supramarginal. The odd anterior ambulacrum is shallow and the tube-feet which are projected from it are large and capitate. The anterior paired ambulacra are somewhat longer than the posterior. The whole of the surface of the test is covered with a close pile of small spines of a dark green colour; those fringing the ambulacral grooves are long and slightly curved, and they bend and interdigitate so accurately over the ambulacra that one might easily overlook the grooves at a first glance. The peripetalous fasciole is somewhat irregular; but in those examples in which it is best defined, it forms a wide arch extending backwards on each side a little beyond the lateral ambulacra of the trivium, and then contracting a little, forms a rudely rectangular figure round the bivium. The paved ambula-

Fig. 7.

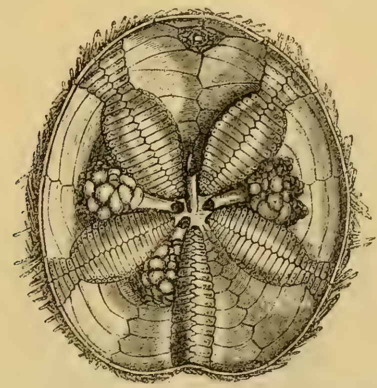


Hemiaster, sp. Apical half of the test of a male example, from within. Natural size.

cral grooves in the male are shallow, not much deeper than the anterior ambulacrum (fig. 7); in the female the pore-plates of

the paired ambulacra are greatly expanded and lengthened, and thinned out and depressed so as to form four deep, thin-walled, oval cups sinking into and encroaching upon the cavity of the test (fig. 8). The ovarial openings are, of course, opposite the inter-

Fig. 8.



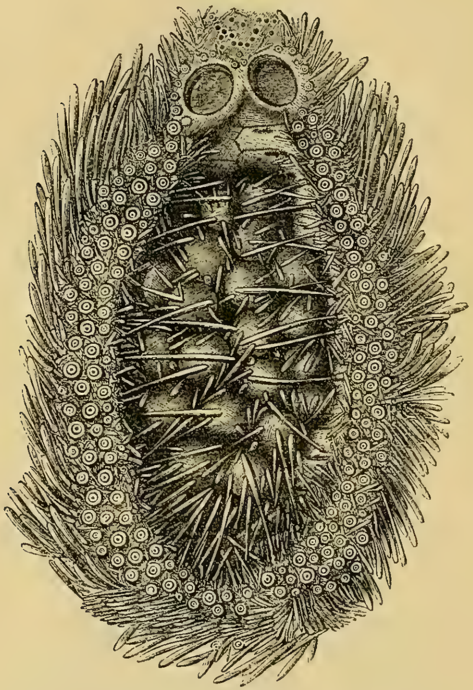
Hemiaster, sp. Apical half of the test of a female example, from within. Natural size.

radial areas; but the spines are so arranged that a kind of covered passage leads from the opening into the marsupium; and along this passage the eggs, which are remarkably large, upwards of a millimetre in diameter when they leave the ovary, are passed, and are arranged very regularly in rows on the floor of the pouch, each egg being kept in its place by two or three short spines which bend over it (fig. 9).

Among the very many examples of this *Hemiaster* which we dredged in Accessible Bay, and afterwards in Cascade Harbour, Kerguelen, there were young in all stages in the breeding-pouches; and although from the large size and the opacity of the egg and embryo it is not a very favourable species for observation, had other conditions been favourable we had all the material for working out the earlier stages in the development of the young very fully. The eggs, on being first placed in the pouches, are spherical granular masses of a deep orange colour, enclosed within a pliable vitelline membrane, which they entirely fill. They become rapidly paler in colour by the development of the blastoderm; and they increase in size probably by the imbibition of water into the

gastræa cavity; and a whitish spot with a slightly raised border indicates an opening which, I have no reason to doubt, is the permanent mouth; but of this I cannot be absolutely certain. The

Fig. 9.



Hemiaster, sp. The arrangement of the eggs in one of the marsupial recesses. Five times the natural size.

surface now assumes a translucent appearance, and becomes deeply tinged with dark purple and greenish pigment; and almost immediately, without any definite intermediate steps, the outer wall is filled with calcified tissue, it becomes covered with fine spines and pedicellariæ, a row of tentacular feet come into action round the mouth, the vent appears at the posterior extremity of the body, and the young assumes nearly the form of the adult. These later changes take place very quickly; but they are accompanied by the production of so much heavy purple and dark-green pig-

ment that it is difficult to follow them. The viscera are produced at the expense of the abundant yelk; and the animals at once take a great start in size by the imbibition of water into the previsceral cavity. The young Urchins jostle one another on the floor of the breeding-pouch, those below pushing the others up until the upper set are forced out between the rows of fringing spines of the pouch; but even before leaving the marsupium, on carefully opening the shell of the young, the intestine may be seen already full of dark sand, following much the same course which it follows in the adult. The size of the test of the young on leaving the marsupium is about 2·5 millims. in length by 2 millims. in width.

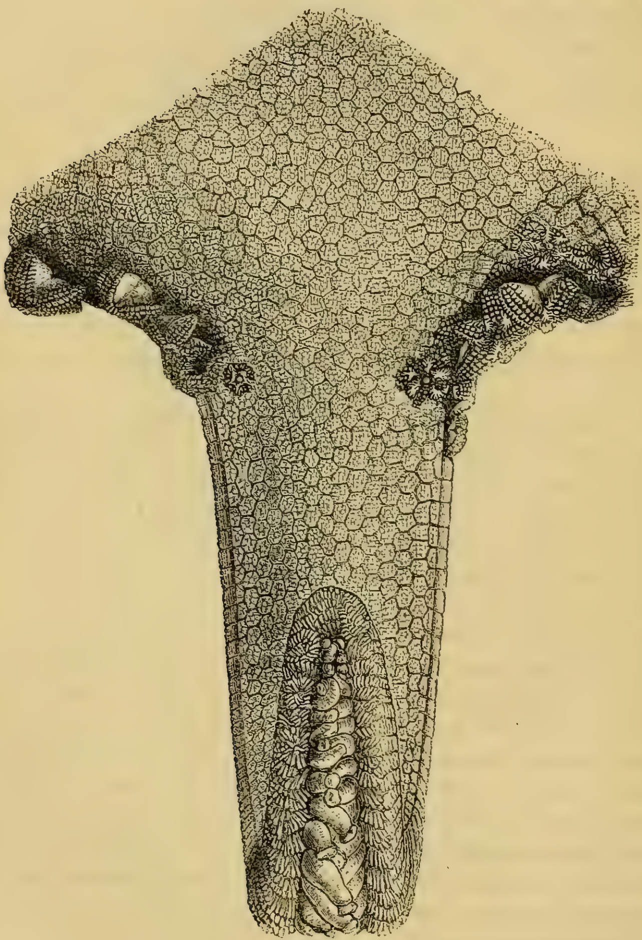
IV. Asteridea.

On the 27th of January, 1874, at station 149, off Cape Maclear, on the south-east coast of Kerguelen Land, we dredged a handsome Starfish of the genus *Archaster* from a muddy bottom at a depth of 30 fathoms. As this species, which is not far removed from *A. andromeda* of the northern seas, appears to be undescribed, I will give it provisionally the name of *A. excavatus* (fig. 10).

A well-grown example is from 100 to 120 millims. in diameter from tip to tip of the arms; the length of the arm is about three times its width near the base, and three times the diameter of the disk. The pairs of marginal plates are long and narrow, running up with a slight curve outwards from the edge of the ambulacral groove until they meet the border of the dorsal perisome above; they are closely set with short blunt spines, which become gradually a little longer towards the radial groove; and at the edge of the groove each plate bears a tuft of about six rather long spines: these tufts in combination form a scalloped fringe spreading inwards on each side over the groove. The dorsal surface of the body is covered with a tessellated pavement composed of capitate paxilli. The heads of the paxilli in close apposition combine to form a mosaic with rudely hexagonal facets; and as they are raised upon somewhat slender shafts whose bases, like the plinths of columns, rest upon the soft perisome, arcade-like spaces are left between the skin and the upper calcareous pavement. The eggs pass into these spaces from the ovarial openings: on bending the perisome and separating the facets, they may be seen in numbers among the shafts of the paxilli. There is a continual dis-

charge of ova into the passages, so that eggs and young in different stages of development occupy the spaces at once. The young do not escape until at least six ambulacral suckers are formed on each arm; they may then be seen pushing their way out by forcing the paxilli to the side, and squeezing through the chink be-

Fig. 10.



Archaster excavatus, Wy. Thomson. Twice the natural size.

tween them. While it is extricating itself, the oral surface of the young is always above; and the centre of the star with the mouth is usually the part which first protrudes; then the arms disengage themselves one after another, many of the brood remaining for a time with one or two arms free and the others still under the paxilli. When the young have become disengaged, they remain for a considerable time attached to the parent by the centre of the dorsal surface. I could never satisfy myself by what means this is effected; the attachment is very slight, and they are removed by the least touch. In this attached stage, until they entirely free themselves, which they do when the number of tentacular feet on each arm has reached about twenty, they cluster in the reentering angles between the arms of the mother, spreading a little way along the arms and on the dorsal surface of the disk; the young escape from the marsupium chiefly in the neighbourhood of the angles between the rays. The madreporiform tubercle is visible in the young near the margin of the disk between two of the arms; but in the mature Starfish it is completely hidden by the paxilli, and no doubt it opens into the space beneath them.

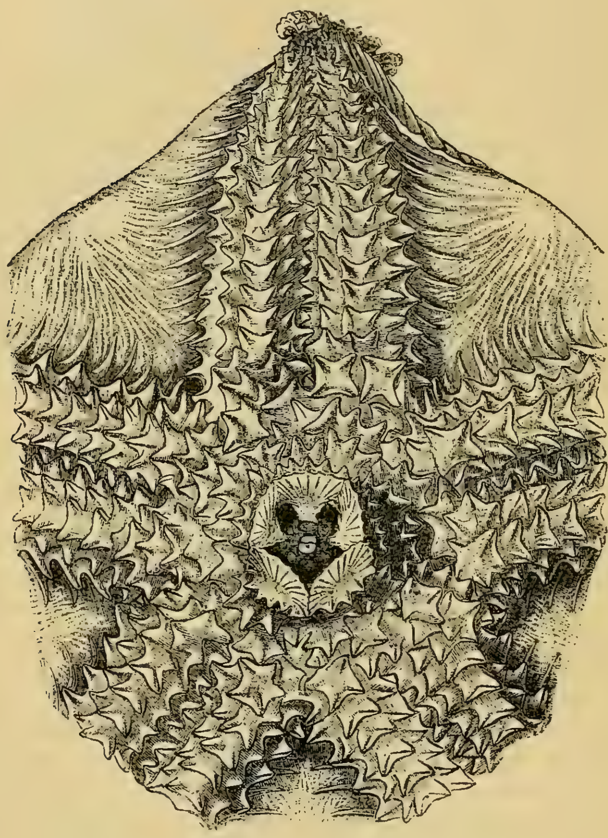
We took *Archaster excavatus* only on that one occasion; and the weather was so boisterous at the time that it was impossible to trace the early stages in the development of the embryo. It is evident that the process generally resembles that described by Professor Sars in *Pteraster militaris*; and it is quite possible that, while there is certainly not the least approach to the formation of a locomotive bipinnaria, as in that species some provisional organs may exist an early period.

In 'The Depths of the Sea' (p. 120) I noticed and figured a singular little Starfish from a depth of 500 fathoms off the north of Scotland under the name of *Hymenaster pellucidus*. This form was at that time the type of a new genus; but the researches of the last three years have shown that, with the exception perhaps of *Archaster*, *Hymenaster* is the most widely distributed genus of Asterids in deep water. It is met with (sparingly, it is true, only one or two specimens being usually taken at once in the trawl) in all parts of the great ocean; and it ranges in depth from 400 to about 2500 fathoms.

On the 7th of March, 1874, we dredged an extremely handsome new form, to which I shall give provisionally the name of *H. nobilis*,

in lat. 50° 1′ S., long. 123° 4′ E., 1099 miles south-west of Cape Otway, Australia, at a depth of 1800 fathoms, with a bottom of *Globigerina*-ooze, and a bottom-temperature of 0°·3 C. (station 158).

Fig. 11.



Hymenaster nobilis, Wy. Thomson. Half the natural size.

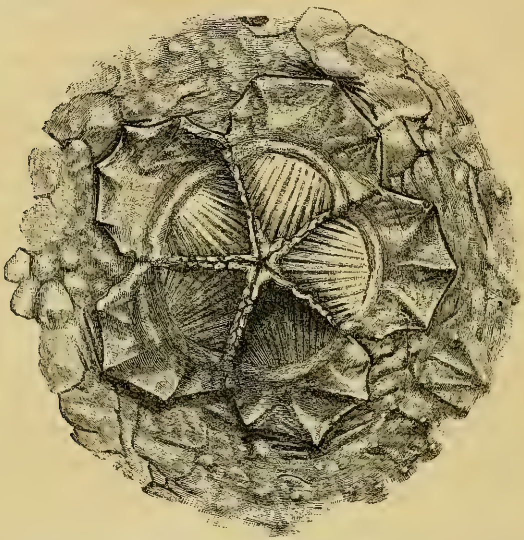
Hymenaster nobilis (fig. 11) is 300 millims. in diameter from tip to tip of the rays; the arms are 55 millims. wide; and, as in *H. pellucidus*, a row of spines fringing the ambulacral grooves are greatly lengthened and webbed; and the web running along the side of one arm meets and unites with the web of the adjacent arm, so

that the angles between the arms are entirely filled up by a fleshy lamina stretched over and supported by spines, the body thus becoming a regular pentagon. The arms are 55 to 60 millims. in diameter; the upper surface of the body, disk, and arms, all the surface, except the smooth membrane between the arms, is covered with fascicles of four to six diverging spines. These spines are about 3 millims. in height; and they support and stretch out a tolerably strong membrane clear above the surface of the perisome like the canvass of a marquee, leaving an open space beneath it. A close approach to this arrangement occurs also in *Pteraster*.

At the apical pole the upper free membrane runs up to and ends at a large aperture, 15 millims. in diameter, surrounded by a ring of five very beautifully formed valves. These valves do not essentially differ from the ordinary radiating supports of the marsupial tent; a stout calcareous rod arises from the end of the double chain of ossicles which form the floor of the ambulacral groove. From the outer aspect of this support three or four spines diverge in the ordinary way under the tent-cover; but from its inner aspect six or eight slender spines rise in one plane with a special membrane stretched between them. When the valves are raised and the pentagonal chamber beneath them open, these spines separate from one another, and, like the ribs of a fan spread out the membrane in a crescentic form (fig. 11); and when the valves close, the spines approximate and are drawn downwards, the five valves forming together a very regular, low, five-sided pyramid (fig. 12). Looking down into the chamber when the valves are raised, the vent is seen on a small projecting papilla in the centre of the floor; and between the supporting ossicles of the valves, five dark open arches lead into the spaces opposite the reentering angles of the arms, which receive the ducts of the ovaries. In the particular specimen to which I have referred, which is considerably the largest of the genus which we have yet met with, there were one or two eggs in the pouch; but they were apparently abortive. It seemed that the brood had been lately discharged; for some oval depressions still remained on the floor of the central chamber, in which the eggs or the young had evidently been lodged. I have on three occasions found the eggs beneath the membrane in the angles of the arms and, in a more advanced stage, congregated in the central tent, but never under circumstances such that I could keep and examine them; exposed

or loosely covered eggs or embryos, or any soft and pulpy organs or appendages are always in a half disintegrated state when they are brought up from such great depths, if they are not entirely washed away.

Fig. 12.



Hymenaster nobilis, Wy. Thomson. The marsupial chamber with the valves closed. Twice the natural size.

As I have already said, *Hymenaster* is closely allied to *Pteraster*: the arrangements of the marsupium are nearly the same in both; and it is highly probable that, as in *P. militaris*, a provisional alimentary tract may be developed in the early stages of the embryo.

There are several fine species of *Hymenaster* within reach of British naturalists in the deep water at the entrance of the Channel and off Cape Clear; but I fear there will be great difficulty in determining this point unless the genus turns up somewhere in shallower soundings where specimens can be taken alive.

V. Ophiuridea.

At station 194, at the entrance of Royal Sound, on the S.E. coast of Kerguelen Land, we dredged, on the 17th of January,

1874, a large number of specimens of a species of the genus *Ophiocoma* of which I can find no description; and I accordingly name it provisionally *O. didelphys* (fig. 13). We afterwards met with the same species in other localities among the fiords and bays of Kerguelen.

The disk is about 20 millims. in diameter; and the arms are four times the diameter of the disk in length. The disk is uniformly coarsely granulated; the arm-shields, which are well-defined through the membrane, are rounded in form and roughly granulated like the remainder of the disk. The character which at once distinguishes this species from all the others of the genus is, that the normal number of the arms is seven instead of five, which is almost universal in the class. The number of arms is subject to certain variation. I have seen from six to nine, but never fewer than six. The arm-spines are numerous and long. The general colour of the disk and arms is a dull greenish brown.

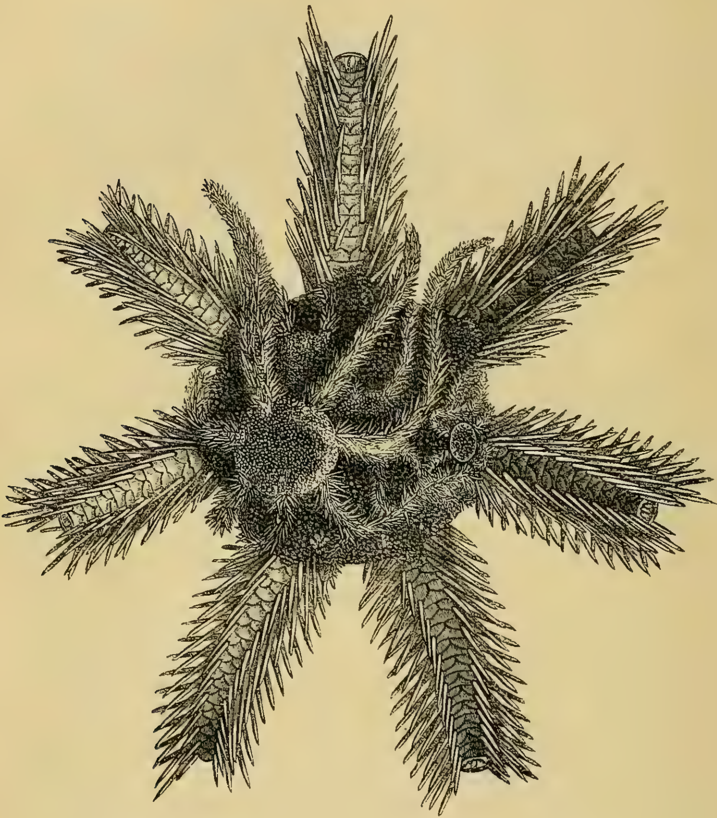
A large proportion of the mature females, if not all of them, had a group of from three to ten or twelve young ones clinging to the upper surface of the disk by their arms: the largest of these were about a quarter the size of their mother; and they graduated down in size until the smallest had a diameter of less than 1·5 millim. across the disk. The largest and oldest of the progeny were always uppermost, furthest from that disk, the series decreasing in size downwards, and the supply evidently coming from the genital clefts beneath. In several specimens which I examined, although by no means in all, there were groups of eggs and of young in still earlier stages, free in the body-cavity in the interbrachial spaces.

It thus seems that in this case the true "marsupium" is a portion of the body-cavity, and that the protection afforded by it is supplemented by the attachment of the young to the surface of the disk, maintained for some time after their extrusion or escape.

The process of propagation in *Ophiocoma didelphys* differs from most of the other cases described in the eggs being successively hatched, and the young being found consequently in a regularly graduated series of stages of growth. Although I had not an opportunity of working the matter out with the care and completeness I could have wished, I feel satisfied, from the examination of several of the young at a very early period, that in this case no

provisional mouth and no pseudembryonic appendages whatever are formed, and that the primary aperture of the gastrula remains as the common mouth and excretory opening of the mature

Fig. 13.



Ophiocoma didelphys, Wy. Thomson. Twice the natural size.

form. From the appearance of the ovaries and of the broods of young, I should think it probable that this species gives off young in a continuous series for a considerable length of time, probably for some months.

I have selected for illustration in the foregoing pages, out of a much larger number, eight examples representing four orders show-

the development of the young of Echinoderms from the egg without the intervention of a locomotive "pseudembryo." As I have already stated, I cannot, on account of the unfavourable conditions for carrying on such investigations under which the majority of the species were procured, say with certainty that no trace of pseudembryonic appendages or provisional organs exists in any of these instances; but I feel satisfied that none such occur in *Psolus ephippifer*, in the Kerguelen species of *Hemiaster*, or in *Ophiocoma didelphys*; nor am I in a position to affirm that in these high southern latitudes direct development is universal in the subkingdom. I believe, indeed, that it is not so; for species of the genera *Echinus*, *Strongylocentrotus*, and *Amblypneustes* run far south, and a marsupial arrangement seems improbable in any of these. It is, however, a significant fact that while in warm and temperate seas "Plutei" and "Bipinnariæ" are constantly taken in the surface-net, during our southern cruise between the Cape of Good Hope and Australia only one form of Echinoderm "pseudembryo" occurred; and that we regarded with some little doubt as the larva of *Chirodota*, from the presence of calcareous wheels in the skin.

South Atlantic,
March 14, 1876.

Note.—Since this paper was written, several notices of these Kerguelen Echinoderms have appeared, both in this country and in America, in connexion with the preliminary reports of the naturalists attached to the Transit Expedition. As, however, this communication is only intended as a preliminary sketch of some of the peculiar phenomena of their propagation, and does not pretend to accuracy in nomenclature, I have thought it better to allow it to remain without alteration. When satisfactory descriptions and figures are published, it will be necessary to go into the whole question of synonymy in detail.—C. Wy. T.

Contributions to the Ornithology of New Guinea.—Part I. Notes on a Small Collection of Birds from South-eastern New Guinea. By R. Bowdler Sharpe, F.L.S.

[Read June 15, 1876.]

So much interest attaches to the natural history of New Guinea, that I am sure the Members of the Society will be pleased to see a few birds which have been forwarded to the British

Museum by the Rev. J. S. M'Farlane. The following is an extract from a letter addressed to me by that gentleman explaining the circumstances under which the specimens were procured:—

"Somerset, Cape York,
"Jan. 31st, 1876.

"The remnant of the Macleay Expedition have just returned from Port Moresby in our little steamer. They have given me a Bower-bird's nest and some specimens, which I also send to you by this mail in a case; they are from the neighbourhood of Port Moresby, about twenty miles inland."

Mr. M'Farlane also writes:—"I send you a Bird of Paradise which I got up the Baxter river; I skinned it myself, and when I got back I got one of the 'Chevert' staff to do it up for me. It is not a very good specimen, but yet the best, I think, out of New Guinea. . . . D'Albertis has not got any of this kind; and the party from the 'Chevert' are not likely to get them at Port Moresby, except mutilated ones from the natives. They seem to come from the head of the gulf."

My disappointment may be imagined on finding that the Bird of Paradise here referred to had been abstracted *in transitu*, apparently by rats, and that only a few red plumes remained of this highly interesting bird, which was apparently an adult male of *P. raggiana*.

1. Geoffroyius pucherani.

Pionias pucherani (*Bp.*); *Finsch, Papag.* ii. p. 385.

The only skin sent is not adult; but on comparing it with our series in the Museum, I believe it to be referable to *G. pucherani*.

2. Domicella scintillata.

Domicella scintillata (*Temm.*); *Finsch, Papag.* ii. p. 752.

I have compared the specimen now sent with others from New Guinea and the Aru Islands, and can find no specific difference, though the Port-Moresby skin is not fully adult. The species is not mentioned in the last of D'Albertis's collection.

3. Trichoglossus massena.

Trichoglossus massena, *Bp.*; *Salvad. & D'Albert. Ann. Mus. Genov.* vi. p. 812.

Count Salvadori compared D'Albertis's single specimen with Mr. Gray's Plate of the species in the late Mr. Brenchley's 'Cruise of the Curaçoa,' and came to the conclusion that the New-Guinea bird was the same. I have compared a fine skin sent by Mr. M'Farlane with the others in the Museum from the Solomon Islands, and can confirm Count Salvadori's determination.

4. Centropus spilopterus.

Centropus spilopterus, *Gray, P. Z. S.* 1858, p. 184; *Schl. Obs. Zool.* iv. p. 11.

This is a very interesting bird, as hitherto the species has been supposed to be confined to the Ke Islands. On comparing the specimen now sent with the type of *C. spilopterus*, I can find no specific differences, nor with two other specimens from New Guinea collected by Mr. Wallace. These latter birds are named *C. violaceus*; but they are certainly not the true species, as they are greenish and have no violet shade about them. The bird will, I believe, ultimately bear the name of *C. spilopterus*,—not that the streaks on the wing-coverts are a specific character; for I regard them as nothing but the last remains of the speckled plumage. Professor Schlegel has given a sketch of the Papuan *Centropi* (Obs. Zool. iv. p. 11), in which he recognizes four species:—

(1) C. menebeki, *Less.*
Hab. New Guinea, Salwatti, Aru Islands, Mysol.

(2) C. bernsteini, *Schl.*
Hab. Salwatti.

(3) C. spilopterus, *Gray.*
Hab. Ke Islands.

(4) C. violaceus, *Q. & G.*
Hab. Soek Island.

This latter species Count Salvadori has named *Nesocentor chalybeus* from a Mysor skin, believing it to be distinct from the true *C. violaceus*, which is from New Ireland.

As regards *C. bernsteini* and *C. spilopterus*, I believe that they are one and the same species, the latter not being quite adult. The synonymy, therefore, will be as follows:—

C. spilopterus.—C. spilopterus, *Gray, P. Z. S.* 1858, p. 184; *id. Cat. Mamm. & B. N. Guinea*, p. 43 (1859); *id. P. Z. S.* 1861, p. 437; *Schl. Obs. Zool.* iv. p. iii; *Gray, Hand-l. B.* ii. p. 214 (1870).—C. violaceus, *Finsch, Neu-Guinea*, p. 160 (1865); *Gray, Hand-l. B.* ii. p. 214 (1870).—C. bernsteinii, *Schl. Obs. Zool.* ii. p. 31, iv. p. 11.

Mr. M'Farlane's specimen measures as follows—total length 19·5 inches, culmen 1·5, wing 8·8, tail 12·5, tarsus 2·0.

5. Graucalus angustifrons, sp. n.—G. hypoleucus, *Gould*; *Salvad. & D'Albert. t. c.* p. 24.

I cannot follow Count Salvadori in referring the white-breasted *Graucalus* of Southern New Guinea to the *G. hypoleucus* of Gould.

No dimensions are given by the last-named author, to begin with; but the bird sent to me by Mr. M'Farlane is rather larger than Mr. Gould's figure. There are several other little points in which the New-Guinea bird differs; but, before every thing, Mr. Gould makes no mention of the black frontal line in the Australian species, which is very conspicuous in the one to which I now give the name of *angustifrons*. I am sorry that I have not in the Museum an Australian skin to compare. At the same time I would draw Count Salvadori's attention to the Aru bird, of which he has probably a better series than we have in London. It has the black frontal line, succeeded by a very distinct line of white which occupies the *hinder* part of the *eyelid*, leaving the fore and lower parts of the latter black like the lores. This is very well marked in the adult Aru specimen now before me, and differs from the New-Guinea bird and from Mr. Gould's figure.

6. Cracticus cassicus.

C. cassicus (*Bodd.*); *Salvad. & D'Albert. t. c.* p. 27.

Two specimens.

7. Eulabes dumonti.

Mino dumonti, *Less.*; *Salvad. & D'Albert. t. c.* p. 828.

Appears to be quite inseparable from other specimens from Dorey and the Aru Islands.

8. Oriolus striatus.

Mimeta striata, *Salvad. & D'Albert. t. c.* p. 828.

The single specimen sent by Mr. M'Farlane agrees with others from Dorey collected by Mr. Wallace. This species seems to vary very little; but the bill shows some difference in length and thickness; both thick- and thin-billed examples, however, occur in the same locality. The streaks on the breast are broader in some birds than in others, being apparently more pronounced in the younger individuals.

9. Clamydodera cerviniventris.

C. cerviniventris, *Gould*; *Salvad. & D'Albert. t. c.* p. 828.

Three specimens of this Bower-bird have been sent; and Signor D'Albertis had already procured a pair on the coast of New Guinea opposite Yule Island. They cannot be separated from Australian examples, with two of which I have compared them; but they differ somewhat *inter se*. The streaks on the forehead appear to extend further up the crown in two of the specimens; and the mottlings on the back are less pronounced than in

one of the Cape-York skins, while the light tips to the wing-coverts and secondaries are not very distinct. All are in somewhat worn plumage. Mr. M'Farlane also sends the bower of this bird, which closely resembles the original one discovered by Mr. Macgillivray and now in the British Museum. It is not ornamented with shells, but has a few berries scattered about on the floor and near the top.

Additional Note relative to the Norwegian Lemming. By W. Duppa Crotch, Esq., F.L.S.

[Read June 15, 1876.]

In the course of a paper which I lately had the honour of reading before the Linnean Society I stated, with reference to the migration of the Lemmings, that this was usually considered to indicate a severe winter approaching.

It is a fact that the Lemmings began to appear last autumn in Övre Gudbrandsdalen; and I now know that the fjeld is overrun with them. Moreover the winter has been very severe, and the summer exceptionally backward, so that ice still remains on many lakes. Yet I am disinclined to believe in this motive for their peregrinations:—first, because they have not chosen warmer quarters than they had "at home," wherever that may be; and, secondly, because, as they live entirely beneath the snow during winter, they are practically unaffected by its severity, and not much troubled by its continuance. With reference to the theory of Atlantic land to which they may in former ages have retreated, I am glad to find that the Norwegian Government have fitted out a ship, the 'Voringen,' under Capt. Wille, for the express purpose of exploring the ocean between Norway and Greenland. The survey in question is to determine the extent of the deep channel which fringes the coast, and to explore the bank between the Faroe Islands and Iceland, as well as to conduct other investigations which may possibly add to (or diminish) the probability of the former existence of land to which, as I have before said, the Lemmings and many other migrants may have betaken themselves, but which has now left no surer traces in these latitudes than the hereditary instincts of its former visitants.

On the Organization of the Ornithosauria. By Harry Govier Seeley, F.L.S., F.Z.S., F.G.S., Professor of Geography in King's College, London.

[Read November 18, 1875.]

(Plate XI.)

The Pterodactyles have long been grouped with the Reptilia by the chief European anatomists. De Blainville placed them as a class between reptiles and birds. Earlier writers (Hunter and Blumenbach), with slender materials, included these animals with birds; and others, like Sömmerring, believed that they had some affinities to mammals. These conclusions necessitate modifications of the zoological ideas of reptile and bird on the part of those who would place Ornithosaurs in either group. But the evidence as to their organization has not been very conclusively set forth; and their place in nature has always been more assumed than proved. The difficulty consists chiefly in the absence from anatomical science of definitions which would fix the zoological value of the characters observed in such fossils as these. No one has specified with sufficient detail the osteological structures which constitute an animal a reptile, or a bird. The task is extremely difficult. My own endeavours that way have led to the conclusion that it is within the limits of possibility for an animal to have its skeletal characters so modified by loss, substitution, or development as to be no longer recognized as a member of its class by the form or proportions of a single bone. The great range of actual variations in the skeleton, seen among fishes, reptiles, and mammals, sufficiently demonstrates that characters must be found more constant than those of the bones before an extinct animal's affinities can be indubitably determined. Therefore, though ordinal groups are defined by the bones without difficulty, the characters of the class can only be found in the soft vital organs.

In the animals whose organization I purpose to examine, two of the vital organs can be investigated—one by the form of the cerebral cavity of the skull, the other by nearly all the bones showing conspicuous apertures which are formed and situate precisely as are the pneumatic foramina in the bones of birds. Such foramina characterize no other kind of skeleton; and since in birds they serve to prolong the air-cells from the lungs into the bones, it can only be inferred legitimately that the similar foramina in fossil bones subserved an identical purpose.

The form of the cerebellum, the size and position of the cerebral hemispheres, and the inferior and lateral place of the optic lobes in the skulls of Pterodactyles offer another coincidence of distinctive structures with those of the class Aves. These are the only vital organs of birds which have a palæontological value: with them may be associated any bones that the conditions of existence tend to elaborate. Any corresponding conception of a reptile is unattainable; hence ideas of the boundaries of the Reptilia must always be vague.

Professor Huxley, in 1867 *, so far modified the ordinary conception of a reptile as to maintain that the Ornithosauria were reptiles with hot blood. I had previously † detailed reasons for believing that they were hot-blooded, but had inferred for them from that an affinity with birds. It is within the limits of possibility for a reptile to be hot-blooded without having the organs associated with hot blood in mammals and birds, since there are hot-blooded fishes.

Professor Huxley followed up his belief that Ornithosaurs were hot-blooded reptiles by another belief that the pneumaticity of the bones and the avian characters of Ornithosaurs might be merely *adaptive modifications* ‡. By that expression Professor Huxley evidently intends to convey the impression that the structures in question are resemblances consequent upon the parts of the body having had to perform identical functions, so that the bones of different animals have acquired identical shapes and structures. For he goes on to say, "Pterodactyles, among reptiles, approach birds much as bats among mammals may be said to do. They are a sort of reptilian bat rather than links between reptiles and birds; and it is precisely in those organs—the manus and the pes—which in birds are the most characteristically ornithic, that they depart most widely from the ornithic type" ‡.

I have given reasons for thinking neither manus nor pes the most characteristic organs of birds, and believe that brain and lungs are organs of incomparably greater value in questions of organization. When, therefore, Professor Huxley launches this scientific dictum without facts to support it, we may usefully compare his views as given at the Zoological Society. "Birds," says Professor Huxley, "have hot blood, a muscular valve in the right ventricle,

* "Classification of Birds," P. Z. S., 1867 p. 417.

† Ann. Nat. Hist. 1866.

‡ Popular Science Review, 1868, p. 242, being a Royal-Institution lecture.

a single aortic arch, and remarkably modified respiratory organs; but it is, to say the least, highly probable that the Pterosauria, if not the Dinosauria, shared some of these characters with them. The amount of work involved in sustaining a Pterodactyle in the air would seem, physiologically, to necessitate proportional oxidation and evolution of waste products in the form of carbonic acid. If so, a proportional quantity of heat must have been evolved, and there must have been a ready means of eliminating the carbonic acid from the blood. We know of no such means except those which are afforded by highly developed circulatory and respiratory organs; and therefore it is highly probable that the Pterodactyles had more perfect organs of this kind than their congeners, accompanied by the correlative hot blood. But since we know that the organs of respiration and circulation of a bat are very different from those of a bird, it is quite possible that those of a Pterodactyle may have been different, in detail, from either"*.

This passage may perhaps be reconciled with the preceding one by means of the dictum often laid down by Professor Huxley, that birds are greatly modified reptiles. But I do not think that the assertion that birds are reptiles would go a great way towards aendering it probable that the pneumatic skeleton of Pterodactyles is an adaptive modification.

On the hypothesis that Pterodactyles are reptiles, Professor Huxley would infer, I think, that flight caused the development in them of the pneumatic skeleton; but seeing that the Cheiroptera, among mammals, have great powers of flight without the skeleton being pneumatic, the statement can but rank as a surmise unsupported by evidence, and, so far, contrary to evidence. Until some living animal, demonstrably reptilian, is discovered to possess limb-bones marked with pneumatic foramina, it seems to me that teaching from any one will lack weight when it refers fossil pneumatic skeletons to the Reptilia. Among living animals the pneumatic foramina exist only that avian lungs may have their air-cells prolonged into the bones; so that no other function can fairly be inferred for them when they are found in fossil bones.

The pneumatic foramina of Ornithosaurs so closely resemble those of birds in almost every bone of the skeleton, that the resemblance often amounts to complete coincidence. The holes are usually in exactly the same positions on each of the bones in both groups; and in both they have the same details of reticulate structure. It must, then, be sound physiology to infer that such

* P. Z. S. 1867, pp. 417–18.

identity of structure is due to identical causation, unless we have at least some evidence to the contrary. If the formula *adaptive modification* means that the Pterodactyles acquired by flight lungs similar to those of birds, it seems as though it were only another and less striking way of saying that reptiles are birds. If Professor Huxley could give to reptiles a bird-like heart and bird-like lungs, it would be important to learn the characters by which they could still be recognized as members of the class Reptilia.

The only remaining vital character which can be recognized in a fossil is the brain; and if the respiratory system of a reptile could become adapted so as to be undistinguishable from that of a bird, what reason is there that it should not be supposed that the brain also of a flying reptile would become indistinguishable from that of a bird?

But between birds and Ornithosaurs there is a great structural resemblance in the brain. A bird's brain so fills its brain-case that a mould of this chamber gives a true idea of the form of the brain. The evidence for the identity of cerebral structure in these two groups rests upon the form of the cerebral hemispheres in the *Pterodactylus longirostris* and on other specimens from the lithographic slate, on an undescribed skeleton from the Wealden of the Isle of Wight, preserved in the collection of the Rev. W. Darwin Fox, and on several fragments showing different portions of the brain-cavity of the *Ornithocheirus* in the Cambridge Upper Greensand. That these latter fossils do not pertain to true birds, remains of which also occur in the deposit, but really belong to Ornithosaurs, is demonstrated by the association of the similar Wealden cranium with a typical Pterodactyle skeleton.

The Upper-Greensand specimens on which I rely for evidence as to cerebral characters are two in number—first, the hinder part of a cranium, and, secondly, a mould of the upper portion of the brain-cavity. The former specimen is in the Woodwardian Museum of the University of Cambridge, and the latter in that of J. F. Walker, Esq., M.A., F.L.S. The Woodwardian specimen shows a vertical section of the brain made in about the line of junction of the frontal with the parietal bones, or just behind that line (Pl. XI. fig. 4). I have excavated the brain-cavity a little, so as to make its outlines distinct; but the hard and brittle character of the specimen rendered it impossible to remove the material which fills it. In its greatest lateral width it measures $\frac{15}{16}$ of an

inch, while its greatest depth in the middle of each cerebral hemisphere is about $\frac{11}{16}$ of an inch. It has the outline shown in Pl. XI. fig. 4. I regard the upper part of the outline as showing that the cerebral hemispheres were divided from each other, as among birds, by a deep impression of the parietal bones, that they were convex from within outward, and deep from above downward, as among birds. At the two lower corners of the section of the cerebrum are two distinct rounded cerebral masses which extend outward beyond the adjacent part of the cerebrum, so as almost to excavate a way through the region of the alisphenoid bones (fig. 4, *o*). The position of these masses below the cerebrum and in the alisphenoids seems to me to demonstrate that they are the optic lobes of the brain; and since they hold the same position and proportion as the excavations for the optic lobes of the brain in the skulls of birds, I infer that in this important point the Ornithosaurian brain is identical with the avian brain. To make this clear, I have prepared a vertical section of the cerebral cavity in the skull of an owl in the same relative plane with the section of the fossil skull, and give the figure for comparison (see diagram, Pl. XI. fig. 5)—from which it will be seen that the only difference between them is, that the owl's brain has a wider cerebrum, and is marked by lateral cerebral impressions which are not shown in the fossil. These differences are only of the kind which distinguish the brains of different genera of birds from each other.

Mr. Walker's fossil displays the upper surface of the cerebrum (Pl. XI. fig. 2), and, so far as regards the form of the cerebrum, confirms the evidence from the Woodwardian fossil; but too little of the under part of the specimen is preserved for it to show the optic lobes. The cerebral lobes are $\frac{10}{16}$ of an inch long, and each is $\frac{7}{16}$ of an inch wide; they have the lateral outline rounded, and the front outlines combined in the middle to make the front of the brain rounded. The lateral outlines similarly converge behind, except that in between the hinder mesial part of the cerebral hemispheres is placed a distinct, small, convex, cerebral mass (Pl. XI. fig. 2, *c m*). It is separated from the cerebral lobes by well-marked grooves directed backward and outward, and does not extend between them for more than $\frac{1}{16}$ inch. In a line with the hinder limit of the cerebral lobes this mass attains its greatest width of about $\frac{5}{16}$ inch; and behind this line the cerebral mass becomes a little narrower. The outermost corners of this mass are each prolonged as a slightly elevated ridge obliquely out-

ward and forward over the cerebral lobes towards the portion of the frontal bone which formed the hinder wall of the orbit. The antero-posterior extent of this cerebral mass (as preserved; for it is somewhat fractured behind) is $\frac{3}{16}$ inch; but on the under side of the fossil (Pl. XI. fig. 3, *c m*), where this brain-region is well defined between the bones on each side of it (fig. 3, *s*), it is $\frac{4}{16}$ inch wide, and extends forward for $\frac{7}{16}$ inch, thus demonstrating that while it is seen for $\frac{3}{16}$ inch behind the cerebrum, it also extends forward under the cerebrum for $\frac{4}{16}$ inch. Therefore I identify this cerebral mass as the cerebellum, and infer from the antero-posterior convexity of its exposed superior portion that its hinder outline was vertical, and did not extend much behind the part of the brain preserved. The ridge over the cerebrum is due to a blood-vessel.

The resemblance of form and arrangement of parts between this fossil animal's brain and the brain of a bird (Pl. XI. fig. 1) amounts, as far as the evidence goes, to absolute identity. This is manifest on comparing a cast of the brain-cavity of a bird with the natural mould of the brain-cavity of the Cambridge Greensand Pterodactyle. The cerebrum being the cerebrum of a bird, the optic lobes those of a bird, and the cerebellum that of a bird, no more perfect specimen could add to the force of the conclusion that the Ornithosaurian brain is an avian brain of typical structure. It seems to me, therefore, an inevitable conclusion that the Ornithosauria are members of the same great class as birds, and are separated from carinate and other birds only by such characters as divide mammalian or reptilian orders of animals from each other—that is to say, by modification of the skeleton. If this claim to admit the Ornithosauria, on account of vital structures, into the class Aves is allowed, then it follows that the skeletal modifications of Ornithosaurians are as much avian structures as the skeletal modifications of the Cetacea, Carnivora, and Monotremata are all mammalian structures.

Turning to the skeleton in Ornithosaurian animals, I propose to point out the characters of the several bones without regard to theoretical conception of the Ornithosaurian organization. On *a priori* grounds it would be reasonable to expect that no greater variations from a common avian plan would be presented than are seen in the variations from the mammalian common plan shown by Edentates, bats, and whales, or are presented by the variations of the several orders of reptiles from the common plan of the Reptilia. I do not think it will be found that the variations from the

avian type of structure exhibited by the skeletons of Pterodactyles are as important as those in the cases cited have been.

First, as to the structure of the skull and vertebral column. Von Meyer has remarked on the preponderating resemblance to the bird's skull shown in the skulls of Ornithosaurian fossils from the lithographic slate of Germany; and elsewhere I have translated his exposition of their characters*. But although he states the several bones, as well as their texture, condition, and arrangement, to be avian, he does not mention the particular birds with which comparison may be made. Some of these comparisons I will supply.

If our attention is turned to the skull, seen from above, as in the published figures and casts of *Rhamphorhynchus Gemmingi*, the outline of the skull is a long triangle terminating sharply in front, similar to that presented by the skull of the great African Kingfisher (*Ceryle maxima*), in which the positions and proportions of nares, orbits, and temporal fossæ correspond closely, the differences being that the Ornithosaur has no premaxillary facial joint, and the bird has no complete temporal fossa. The common Heron (*Ardea cinerea*) also resembles the Pterodactyle in the fore part of the head, but behind the eyes it has the skull both longer and larger.

If the comparison is made from the side view, the small backwardly placed nares and complete orbit of *Rhamphorhynchus Gemmingi* show some resemblance to these organs in the parrots. The orbital circle, however, is formed in different ways. An interesting resemblance, both in the position and proportion of the several regions of the side of the skull (nares, orbits, cerebral space and quadrate bone), may be noticed on comparing *Pterodactylus longirostris* and *P. scolopaciceps* with the Bar-tailed Godwit (*Limosa lapponica*). The quadrate bone is similarly inclined forward in the Curlew, Snipe, and other birds, while it articulates inferiorly with the squamosal region of the brain-case, as the quadrate bone articulates in birds and in no other animals.

When a bird has a circular orbit for the eye, the circle appears to be completed below by a downward and backward growth of the lachrymal bone uniting with a forward growth of the frontal bone in its postfrontal region. Many water-birds, especially the Maned Goose (*Bernicla jubata*), the Swan, and the Teal, show an approximation to such a condition. The Great Bustard, too, shows

* Ann. Nat. Hist. 1871.

forward growths both from the squamosal and frontal margins; and in the Snipe both of these processes meet the lachrymal bone. Thus one distinctive feature of the bird's orbit, by which it differs alike from Ornithosaurs, reptiles, and mammals, is that it forms a circle above the bar containing the malar bone, so that the malar bone is not admitted into the orbit of the eye.

In the Ground-Hornbill (*Bucorvus abyssinicus*), however, and in the Shoebill (*Balaeniceps rex*), the lachrymal bone meets the malar bar without uniting with it, and the postfrontal region of the skull is prolonged downward almost as far as the malar bar—thus showing that it is possible for a bird to have its orbital circle formed by the same bones, and in the same way, as among Pterodactyles: that is, the frontal bone is above, the lachrymal in front, and the malar below. But Ornithosaurs sometimes differ from birds in admitting the quadrato-jugal bone into the orbital circle behind. The quadrato-jugal bone has, I believe, in most specimens hitherto been regarded by others and by myself as the postfrontal bone; but the postfrontal bone seems to me now usually to have no separate existence in Ornithosaurs, being united with the frontal bone as in adult birds.

My reasons for making this determination are, that the bone in question appears usually to have two articulations with the quadrate bone, and to be situated between the malar bone and the proximal end of the quadrate bone. Since the frontal bone expands at the back of the orbit as in birds, and the squamosal bone similarly contributes to the wall of the brain-cavity, there can be no reason for supposing that the bone in question, which makes the outer boundary of the temporal fossa, is the postfrontal, so long as the quadrato-jugal bone remains unaccounted for. The position of the bone is somewhat analogous to that of the quadrato-jugal *Hatteria*, so far as concerns the orbit, and similar to the quadrato-jugal in *Iguana* in its relations to the quadrate and squamosal bones, and therefore is more lizard-like than the quadrato-jugal of birds. But, in consequence of this arrangement, it results that the malar bone unites with the distal end of the quadrate bone; and this union distinguishes Ornithosaurs from all existing animals, whether birds or reptiles. These differences from birds, even from a morphological point of view, ought not to be regarded as resemblances towards one class of animals or another, but merely as characters useful in the subordinate details of classification.

No ornithosaurian fossil has displayed the undisturbed palatal aspect of the skull; but in *Cycnorhamphus suevicus* and *Pachyrhamphus crassirostris* the palatal bones may be detected as slender elements comparable to those of birds. The palate of *Pachyrhamphus* may have approximated towards the palate of such a struthious bird as the Emu; but *Cycnorhamphus* had a palate more like that of a natatorial or gallinaceous bird, as I have already tried to show in a published restoration *. In neither of these genera, nor in any known Ornithosaur, have the palatal bones any reptilian features.

Formerly considerable weight was given to the occurrence of teeth in Ornithosaurians as a point of resemblance to reptiles; but this feature is now balanced by the occurrence of similar teeth, according to Professor Marsh, in the jaws of the cretaceous birds *Hesperornis regalis* and *Ichthyornis dispar* †, as well as by the presence of teeth anchylosed to the jaw in *Odontopteryx* ‡. Since *Hesperornis* possesses so many of the characters of existing birds, there seems to be no reason why the occurrence of teeth in Pterodactyles should be regarded as a character more reptilian than avian. Some years ago I pointed out that since the teeth in the maxillary bone in the Delphinidæ are all simple and conical with one fang, the occurrence of teeth similarly simple in Ornithosaurians is no more a resemblance to reptiles than it is to mammals, and is therefore valueless as a mark of affinity. The tooth-structure is not very like that of any living animal.

When printing my book on the Ornithosaurians, I stated that the teeth resembled those of some mammals in the dentinal cells. The point always appeared to require further examination; and beautiful new sections made for me by Mr. Cuttell, of New Compton Street, demonstrate no such structure. From studies of sections of teeth, it seems to me that we can by no means certainly determine, on microscopical evidence, whether a tooth is reptilian or mammalian, especially when the type to which it belonged is extinct.

In longitudinal sections of the tooth of *Ornithocheirus* from fang to crown (Pl. XI. fig. 11) the calcigerous tubes radiate as in the teeth of Ichthyosaurs and Plesiosaurs; they are wavy tubes which occasionally bifurcate, but are remarkable for the many branches

* Ann. Nat. Hist. 1871, vol. vii. pl. 2.

† Am. Jour. Sci. vol. x. 1875, pl. 10.

‡ Quart. Journ. Geol. Soc. vol. xxix. pl. xvi.

which each gives off at right angles. The branches appear to be best seen in the transverse section, where many can be traced extending in a wavy course for some distance at right angles to the tube from which they are given off. The branches are sometimes as large as the principal tubes, which, towards the outer part of the tooth run straight. In the transverse section (Pl. XI. fig. 12) the branches appear to unite the tubes together much as the principal tubes are united in some Carboniferous species of the coral *Syringopora*; but this appearance is probably delusive. The enamel is very thin, and only distinguished from the dentine by being perfectly translucent; but calcigerous tubes are continued into it without any break. Exactly the same kind of structure has not been figured, so far as I know, in any existing animal. It reminds me of that attributed by Professor Owen to *Saurocephalus*; but in this fish, which has a similar form of tooth, the tubes are fewer beyond comparison. Among reptiles, there is a resemblance in the number of tubes to *Iguana*. Cetaceans and bats indicate structural resemblances probably as close, though in those animals the tubes are fewer.

The only remaining points of importance in the skull are that the eyes usually, if not always, abut against the anterior walls of the brain-case, as they do in some birds, and that the skull is articulated at right angles to the vertebral column, as it is in all birds. Perhaps little importance should be attached to this latter character, although it is found in no reptile, because in Cetaceans the head is in a line with the vertebral column, as it is in reptiles, while in the fish *Hippocampus* the head is placed at an angle to the vertebral column, as it is in birds.

Finally, every point of the Ornithosaurian skull upon which I have not offered comment presents absolute identity with the corresponding structures in birds. I now pass them over, not because their great weight should be overlooked in an attempt to estimate the osteology of the group, but because there are no new facts to be adduced in addition to those given in previous writings on the subject.

On the whole, I do not regard the Pterodactyle's skull as differing from the bird's skull to any thing like the same extent as the skulls of birds, or of Pterodactyles, differ from each other.

The vertebral column presents considerable variety in the Ornithosauria. Owing to the conditions of fossilization, the num-

ber of vertebræ in the several regions of the body is not easily determined. There appear to be usually seven or eight cervical vertebræ, which is fewer than is recorded in any bird, though the number is not more reptilian than mammalian. Sometimes the vertebræ are elongated, subcylindrical, and without conspicuous processes, as in *Pterodactylus longirostris*, and then they closely resemble in form the vertebræ in the neck of the Purple Heron. If there were any ground for comparing the animal, as a whole, with Terrapins, a certain parallelism would be remarked in the form of the neck-vertebræ of the two groups.

In other genera of Ornithosaurs from the lithographic slate, such as *Cycnorhamphus*, in *Dimorphodon* from the Lias, and in all the Ornithocheiroidea from the Cretaceous strata, the neck-vertebræ are large, broad from side to side, more or less flattened on the under face, and have the neural arch extending transversely beyond the centrum, as in *Bucorvus abyssinicus*. But birds, even raptorial birds, have a much smaller development of the neural spine. No reptile has a neck formed on this plan.

As yet, the nature of the articulation of the centrum in the vertebræ of most Ornithosaurs from the lithographic slate is unknown, though the condition is certainly not uniform. In the genera from the Cambridge Upper Greensand and the Chalk all the vertebræ have the centrum depressed ovately, concave in front, and convex behind. Some of the vertebræ of *Dimorphodon* have the same character. But the elongated caudal vertebræ of that genus, like similar vertebræ from the Oxford and Kimmeridge Clays, have the articular ends of each centrum biconcave, as are the later caudal vertebræ in most Vertebrata. This procœlous character of the neck and back is at once a difference from all known birds, and a resemblance to the form of vertebral articulation among lizards, serpents, and crocodiles. The resemblance is the more worthy of being carefully weighed, because no mammals are reported to possess procœlous vertebræ. Although, no doubt, a biconcave vertebra, such as that of *Ichthyornis*, or of the tail of an existing bird, might become as easily moulded to the lacertilian as to the avian form, hitherto the condition has not occurred in birds, recent or fossil; but on that account the probability of its occurrence hereafter is not decreased.

Nevertheless the character can scarcely be called reptilian, since in such reptiles as the Chelonians and Rhynchocephala for example other modes of vertebral articulation prevail. If the

character is reptilian it must be a resemblance to either crocodiles, lizards, or serpents, but can only be so regarded provided the predominant resemblances of the skeleton prove to be with those ordinal groups.

The Ornithosaurian vertebræ, however, show a resemblance to those of birds and many mammals in the small size of the centrum and in the large extent to which the sides of the neural arch contribute to form the lateral parts of the intervertebral articulation. I have not detected a like structural condition in the vertebræ of reptiles. But the character becomes modified in importance by the relation being reversed in some mammals, since the canal for the spinal cord is sometimes partly formed by the centrum in Cetacea.

The atlas and axis resemble those of a bird in proportion and form; but the condition of the odontoid process is different. When the atlas separates from the axis of a bird, the odontoid process is seen usually, if not always, to have formed the upper part of the cup for the occipital condyle. In *Ornithocheirus* a perfect disk comes away from the axis, and displays a slight prominence on the upper part of the anterior face of the axis with a concave space around it. But I have no evidence whether the elevation represents the centrum of the atlas in a diminished form, or whether that bone unites with the other elements of the first vertebra, after the pattern of *Plesiosaurus* and *Ichthyosaurus*, as would seem not improbable. It thus differs alike from birds and reptiles.

Von Meyer states that the dorsal vertebræ vary in number from 12 to 16; but in associated sets of bones from the Cambridge Greensand the dorsal vertebræ are few. They resemble those of a bird in relative shortness, but do not appear to form a transverse platform from which the neural spine rises, as do similar vertebræ of adult birds and crocodiles, in this respect being more like vertebræ of lizards.

Sometimes the centrum is flat on the visceral side, as in *Apteryx*, sometimes rounded, as in such birds as the Heron. Altogether the dorsal region is less bird-like than is the neck, but the divergences do not show marked resemblances to any existing ordinal group of reptiles.

The nature of the attachment of the ribs may perhaps be variable. Several forms certainly possessed double-headed ribs like those of birds and mammals; and all specimens and figures, including

those of *Pachyrhamphus crassirostris*, appear to me to demonstrate that the articulation of the ribs was avian, and not crocodilian.

The sacrum differs from that of a bird chiefly in its shortness, and in including but few vertebræ. Prof. Huxley has proposed to call the five posterior vertebræ of the sacrum in a chicken caudal, limiting the term "sacral" to the five vertebræ anterior to these, while the four vertebræ anterior to the latter are named dorso-lumbar. The number of the vertebræ is variable in these regions, and they often differ slightly on the two sides of the animal. While such division on homological grounds is valuable, on morphological grounds it is untenable, since at no period of the development of the chick do the vertebræ named caudal and dorso-lumbar form part of either the tail or back.

The points stated by Prof. Huxley serve to show probable limits of variation among fossil birds, and that animals may be avian in having only four or five vertebræ in the sacrum; although they would then probably belong to a new subdivision of the bird class. In several Ornithosaurs there are four, five, or six vertebræ in the sacrum, so that the number of vertebræ is so far in harmony with the avian type as conceived by Professor Huxley. In having the neural spine well developed there is a resemblance to the anterior part of the avian sacrum, while in having the transverse processes well developed, there is a resemblance to the hinder part of the avian sacrum. The sacrum is therefore distinct from that of birds, and yet altogether unlike the sacrum of any reptile.

The caudal vertebræ vary considerably in Ornithosaurs. All the members of the Cretaceous order ORNITHOCHEIROIDEA apparently have elongated caudal vertebræ unlike those of existing birds, and resemble the anterior caudal vertebræ of reptiles in having the centrum concave in front and convex behind. But, so far as I am aware, in all the other forms (the PTERODACTYLIA) the caudal vertebræ, whether short as in *Pterodactylus*, or long as in *Rhamphorhynchus*, have the centrum flat or slightly concave at both ends.

In some birds the caudal vertebræ often present a marked resemblance in proportion and form of the articular face to those of *Plesiosaurus* and occasionally in Ornithosaurs the tail may have avian proportions. But the neural arch is never so elevated as in Birds, even when it is preserved; for in some specimens from the lithographic slate the neural arch in the tail is said to be absent, as it is in the later caudal vertebræ of mammals.

Thus it appears that the vertebral column shows some striking

resemblances to certain groups of reptiles, especially in the form of the intervertebral articulation; but this structure is coupled with so many other characters (especially in the neck and sacrum) which are not found in reptiles, that, unless the predominant resemblances of the rest of the skeleton prove to be with the Reptilia, it would be philosophical to infer that other groups of animals besides reptiles possess procœlous vertebræ. We have already seen that opisthocœlian vertebræ occur in every division of the vertebrata; and this fact, when considered in connexion with the variations of intervertebral characters in different vertebrate classes, would appear to render the procœlous articulation less important than it has been supposed to be by morphological anatomists.

The pectoral and sternal bones are about as markedly avian as is the skull. The sternum appears to differ from that of most birds in being as broad as long, while it is probably relatively much shorter. The keel is only well developed at the proximal end as in the Gannet; and the semicircular posterior border to the bone, observable in some German specimens of Ornithosaurs, is a character not seen in birds. Von Meyer reports, in some specimens of *Rhamphorhynchus*, that the lateral portions of the sternum to which the sternal ribs are attached are distinct ossifications, as they are in at least some young birds, such as the chicken. The sternal ribs which articulate with the sternum are ossified, as is the case with birds; and there is a resemblance to birds in that only a few join the sternum. But there is a striking difference from birds in that, behind the sternum, V-shaped abdominal ribs are freely developed, as in *Hatteria* &c., and these structures do not occur in birds. I have moreover never seen in an Ornithosaur any trace of the epipleural element characteristic of *Hatteria*, of Crocodiles, and of Chelonians, and so often seen in the ribs of birds; so that, if developed, it must have been cartilaginous.

The right angle at which the coracoid meets the scapula is characteristic of carinate birds. The coracoid much resembles the bone in birds, yet has distinctive differences. The bird-like features are the elongated form, rounded inner side, and compressed outer margin of the bone; the distal articulation with the sternum is concave from within outward, and convex from before backward, as in birds; and the proximal articulation with the scapula similarly looks backward. But there is a difference, in Cretaceous species, from the coracoid of a bird in that the bone is not prolonged proximally beyond the articulation for the humerus.

With that character necessarily follows the absence of a furcula, seeing that there is no surface on the coracoid to which it might be attached.

In the so-called *Rhamphorhynchus Bucklandi*, and apparently in *Dimorphodon*, this clavicular process of the coracoid is developed, though perhaps a clavicle may not be inferred for those genera. The scapula is a bone which, in *Dimorphodon*, is compressed and curved like the scapula of the fowl, and was similarly placed. In the Oolitic fossils the bone is still more like the scapula of a bird than any thing else; but in the Cambridge-Greensand genera the form of the bone is subcylindrical, terminating backward in an expanded and abruptly truncated and ovate end. This is not bird-like, and not like the bone in any other animal.

The only reptiles which have the pectoral arch similarly consisting of scapula and coracoid are crocodiles and chameleons. Since the scapula is elongated in *Chamæleo* as well as in the Mole (*Talpa*), the elongation is evidently not correlated exclusively with development of the pectoral muscles. And since the coracoid has no corresponding form or function in bats, the shape of that bone in Pterodactyles cannot be explained by its function only. The Ornithosaurian humerus, with marked resemblances to birds and chameleons, is yet so different as not to be mistaken for either. Remembering that Ornithosaurs were often quadrupedal, and that the whole fore limb was usually modified for walking as well as for flight, it is scarcely to be expected that the resemblances of limb-bones to those of any existing mammals should be remarkable.

In the forearm both bones are large and usually of equal size, as Von Meyer and Professor Owen long since pointed out; so that the ulna is as large as in a bird, and the radius much larger. The ulna is large in birds, I presume, because the feathers are attached along its shaft, and the equality in size of the bones in Pterodactyles may indicate that both bones performed nearly equal amounts of work. Still the resemblances to birds are more marked than to other animals. There is, however, in many species a third bone in the forearm, which is articulated to the pisiform bone. It is imperfectly developed proximally, and appears to correspond to the olecranon seen in the skeleton of *Ophthalmosaurus*. In *Cycnorhamphus* a second bone of this kind appears to be present, the homology of which is more difficult to understand.

The carpus has always been regarded as reptilian, seemingly because it consists of two rows of bones. It is a very variable

part of the Ornithosaurian skeleton. In 1870, in my "Remarks on Prof. Owen's Monograph on *Dimorphodon*," I pointed out that in the Cretaceous genus *Ornithocheirus* (Pl. XI. fig. 6), the carpus consists of three bones:—a proximal carpal, as in birds, which corresponds closely in form with the bone in the ostrich (Pl. XI. fig. 7); a lateral carpal, as in birds, which I interpreted as the pisiform bone; while the third bone or distal carpal of *Ornithocheirus* is, in birds, of the same form, but becomes anchylosed to the metacarpus. Until placed in separate genera by me*, the Cambridge-Greensand fossils had been included by Prof. Owen in the genus *Pterodactylus*. Prof. Owen now, however, in recent publications of the Palæontographical Society, adopts the generic groups which I suggested, but discards my names, alleging that there is no evidence of avian type of carpus to justify the name of *Ornithocheirus*.

If the foregoing account of the carpus does not justify the name, I might quote Dr. Rosenberg's observations†, that in early life there are two elements in the distal carpal row of birds, and that these carpal bones subsequently unite with each other. They correspond with the *four* metacarpal bones of birds, and become subsequently united to the metacarpus. Thus in the composite structure of the carpus and in the number of metacarpal elements there is an absolute agreement with the conditions in embryonic or young birds, while I am aware of no such resemblances to reptiles. If the fourth metacarpal of the bird becomes absorbed, then *Ornithocheirus* apparently agrees with birds in having three metacarpal bones. But it differs from birds in the distal carpal (which is separated from the metacarpus) being made up of three carpal elements, one corresponding to each of the three metacarpal bones—although in the mature animal the metacarpals are not always attached to their corresponding carpal ossifications. The distal carpal bone of *Ornithocheirus* sometimes shows on its proximal surface a Y-shaped groove; and occasionally the sutural surfaces indicated by this groove remain unattached to each other. Hence the bones are placed one above the fork of the Y, and one on each side of its stem; so that they are not arranged in one line, as is usual, but in two lines. These three bones are probably the trapezoid, the magnum, and the unciform (Pl. XI. fig. 9). The middle bone of the Y, I regard as the magnum squeezed out from between the other two, as is the case with the same bone in the horse and

* 'Index to Secondary Reptilia,' &c., 1869, and 'Ornithosauria,' 1870.

† Quoted in Foster and Balfour's 'Embryology,' p. 175.

other animals in which the metacarpus is unusually modified. One of the two other bones terminates at the end in a rounded articular edge, which gives attachment to another bone, which for convenience may be named the lateral carpal; it is evidently homologous with the lateral carpal bone of birds, which is probably the pisiform bone. I am aware that Dr. Foster and Mr. Balfour regard that bone in birds as the united lunar and cuneiform bones. Whichever nomenclature should be preferred, all are agreed that it is attached to the exterior side of the distal carpal; and as it has the same articulation in *Ornithocheirus*, it follows that the element of the Ornithosaurian distal carpal to which it is attached is the unciform bone; and to this bone the minutest metacarpal bone is attached (Pl. XI. fig. 10). The other carpal element is therefore the trapezoid; and that bone will be seen to give attachment to the wing metacarpal bone. The structure of this carpal row, and the articular surfaces on its distal face, demonstrate that the great wing-finger of Ornithosaurs is not the fifth digit, or little finger, as stated by the older writers, but the middle finger, or index finger, as I first determined many years ago. This is a point of some importance, since it removes the Ornithosaurian hand from the category of osteological anomalies, and shows that it is constructed on a plan absolutely identical with the plan of the hand in birds; for it is the second or index digit in birds also which is chiefly extended for the support of the wing-membrane.

The distal carpal row of *Ornithocheirus* appears to differ from the corresponding bones in birds in being formed from three centres instead of two, though the rule is not constant for all Ornithosaurs; while, on the other hand, we have no evidence that the two distal carpal cartilages, detected by Dr. Rosenberg, characterize the distal carpal row of all birds. In any case we are justified in correlating the two carpal cartilages of the young bird with the existence of the two metacarpal bones of the adult which are anchylosed to them; while, since Pterodactyles have three or four metacarpal bones fully developed, we may expect to find a corresponding number of carpal elements in the distal row of the Ornithosaurian carpus.

I prefer to regard the lateral carpal as the pisiform bone, because it articulates proximally with a third bone of the forearm, which becomes intelligible as the distal end of the olecranon—an interpretation to which I am led by a study of certain Ichthyosaurs, regarding the olecranon as a third bone of the forearm, external in position to the ulna, and capable of being developed either

proximally or distally. Whatever value may be attached to the resemblances of this carpus to the carpal bones of birds, it appears to render a modification necessary of Prof. Huxley's statement that the manus is a part of the skeleton in which birds and Pterodactyles diverge most widely.

Turning next to the metacarpus, I find that just as Dr. Rosenberg describes four metacarpal cartilages, as I also have observed in the chicken, so Pterodactyles from the Lithographic slate have four metacarpal bones—one of them more developed than in birds, and three thread-like, or at least much more slender than the other. The *Ornithocheirus* from the Cambridge Upper Greensand shows on the distal surface of the distal carpal three distinct articulations for metacarpal bones, two of which have articular surfaces of not dissimilar size; and these seem to me to correspond to the two elongated metacarpal bones of birds. The fact of the metacarpal bones not being anchylosed together has never been thought to militate against the systematic position of *Archæopteryx* as a bird. Like the blended characters of the metatarsus in birds, it is so certainly functional that I am not disposed to regard the separate condition of the metacarpal bones either as a very important character, or as an evidence of reptilian affinity in Ornithosaurs. The Pterodactylian metacarpus, then, as Professor Owen has demonstrated, does not diverge greatly from the metacarpus of *Archæopteryx*.

The resemblance of the wing-digit to that of a bird is very remarkable, since the difference chiefly consists in the introduction of extra phalanges into the Ornithosaurian wing-finger.

There is felt by some writers to be a difficulty in accepting any modification of the old interpretation of the Ornithosaurian hand, on account of the number of phalanges in each of the four digits present in all Pterodactyles from the Oolitic rocks, though Von Meyer has said that the number of the phalangeal bones is variable in those animals. The number is usually stated as 4, 4, 3, 2; which, according to the interpretation of the hand just given, would read, four bones in Digit II., four in Digit III., three in Digit IV., and two in Digit V. So long as the Pterodactyle was supposed to be a modified lizard it was not unnatural that the reverse reading should be taken, and the increase in number of phalanges considered to be in harmony with the lizard type, in which the phalanges from first to fifth are 2, 3, 4, 5, 3; while in the chameleon they run, from first to fifth, 2, 3, 4, 4, 3. Thus, striking off the fifth digit of the cha-

meleon, there looks to be an *à priori* probability that the number of phalanges, digit for digit, is identical with that in the digits of of the Ornithosaurian hand. Von Meyer appears to have suspected a fallacy in this conclusion; for, in his 'Fauna der Vorwelt,' he observes, "even Cuvier believed that the wing-finger corresponded to the fourth finger of lizards; but lizards, like crocodiles, have five fingers, so there can be no real affinity." In this is a suggestion of explanation of the difficulty. If the animal were essentially a lizard, then it would be improbable that the lizard plan of the hand would be departed from, even when modified for flight. But if the animal is not a lizard, or even a modified lizard, then there can be no *à priori* reason for anticipating any structure of hand whatever. For though mammals usually have three phalanges in each digit, Cetacea are not to be classified by digital rules. If the Ornithosauria are admitted to be an extinct order either of reptile or bird type, then, bearing in mind the variation in the number of phalanges of the digits in existing reptile orders, I cannot realize any insuperable difficulty to believing that the phalanges of the second to fifth digits of chameleon, 3, 4, 4, 3, might under exceptional functional conditions become altered to the Ornithosaurian formula 4, 4, 3, 2. The matter of a phalange more or less in a digit in an extinct type is not the sort of evidence on which to settle an animal's place in nature, or on which to determine such homologies as those in question. The carpus is the only key to the structure of the hand. If that has been correctly interpreted in the Cambridge-Greensand *Ornithocheirus*, then the inferences which it enforces must, I consider, be true also for the other genera of Pterodactyles, no matter what the number of bones may be in their digits. In short, this portion of the skeleton diverges wider than any other from the bird and reptile types, and is distinctive of Ornithosaurs.

Thus, reviewing the morphological indications of the fore limb, and of its scapular arch, I fail to detect any characters which can be shown to be decidedly reptilian; nor do I detect, except in the ways pointed out, any remarkable divergence from birds; though the divergences are usually sufficient to prevent an experienced anatomist from mistaking even isolated Pterodactyle bones for the bones of birds. On the other hand, the whole limb in every part shows characters which are only found in the bones of birds, which I cannot see my way to explain as adaptive modifications, because bats, which similarly fly, have no such characters. The patagial

membranes, which are well preserved in a specimen figured by Winckler as *Pterodactylus Kochii*, prove to be exactly in the same regions as the patagial membranes of the wing of existing birds; while the great elongation of the wing-bones in Ornithosaurs only extends the wing to a similar extent to that in which the wing of a bird is extended by its feathers. It is reasonable therefore to suppose that if less organic energy were directed to formation of the covering for the skin in birds, more might go to the elongation of the wing-bones.

Finally, in the absence of any manner of evidence as to the existence of winged reptiles, and in face of the evidence as to avian resemblances which has been given, it seems to me hazardous to infer that the characters which some Pterodactyles may seem to have in common with reptiles in the bones which have been discussed, indicate any close genetic relation between the two types.

The pelvis and hind limb are the least reptilian portions of the Ornithosaurian skeleton. Whatever may be the physiological significance of the relation of direction of the ilium to the sacrum in the vertebrate classes, the morphological fact remains that in birds the ilium extends along the sacrum both in front of the acetabulum for the femur and behind it, and that this condition characterizes no other existing group of animals. In mammals and batrachians the ilium is directed forward, while in reptiles it usually directed backward or is vertical. And though the ilium of a seal makes an approximation to the ilium of a crocodile, which may be to some extent functional, these osteological characteristics of classes are sufficiently well marked to suggest the inference that an animal with the avian form of ilium is likely to be related to birds, either as an ancestral or as a parallel group. Like the whole pelvis the ilium is variable among Ornithosaurs; and in so far as it diverges from the avian form, it approximates to the mammalian shape. But it is rarely, if ever, so deep as in a bird, never has the characteristic avian form, terminates at both extremities in relatively narrow rounded processes, and is attached to sacral ribs which are longer than is usual among birds. There is also a remarkable difference from birds in the ilium joining the pubis and ischium in the middle of the acetabulum, which is thus made imperforate in the specimens which I have examined. This imperforate character is also found in reptiles. And though the ischium and pubis are occasionally directed backward after the

manner of the *Apteryx*, the two bones are usually united by suture throughout their length, so as to leave a small obturator foramen near to the acetabular border. If this foramen were larger, the bones which enclose it would bear a close resemblance to those of the *Echidna*, which is the more interesting since, in common with the lower mammals, the Ornithosaurs also possess prepubic or marsupial bones. These bones are of different forms in the several groups of Ornithosaurs, being triangular in *Dimorphodon*, T-shaped in some genera from the Lithographic slate, and probably forming by union with each other a bow-shaped arch in another genus from Solenhofen.

The exact position of the prepubic bone on the anterior margin of the pubis is not quite certain, though probably placed in the middle of the margin; and there may be some doubt whether it is truly homologous with the marsupial bone. In Chelonians and Lacertilians a prepubic process is developed, often of large size, and the ornithosaurian bone may be likened to what such a process might become if converted into a distinct osseous element. A smaller but similar process is also to be seen on the pubic bone in some birds, such as the *Apteryx*, and in many mammals. In *Iguanodon* the process is enormous. The pelvis might perhaps as easily be regarded as of a modified mammalian type as avian; but it does not closely resemble either, and is somewhat intermediate between them. In this light it may serve to point a caution by showing that monotreme characters in the pelvis may coexist with lacertian characters in the articulations of the vertebræ. The pelvic bones met in the median line of the body, as in mammals and reptiles, and were not divided from each other, as is usual among birds.

The femur is in no respect a reptilian bone, unless it be in sometimes having the articular head directed a little forward. But in most English specimens there is a distinct articular head separated from the shaft of the bone by a considerable neck, which is directed upward as in carnivorous mammals; though in the genera from the lithographic slate the proximal end of the bone is more like the same part in birds. The distal end is rarely so deeply grooved in front as in the bird's femur, though it corresponds in thickness and form and does not approximate towards mammals.

The tibia and fibula are altogether avian, so much so that in many genera no anatomist could distinguish them from the same

bones in birds. The fibula, slender, style-like, developed chiefly at the proximal end (Pl. XI. fig. 8, *f*), is often prolonged, no thicker than a thread, down the tibia to its distal end. The tibia expands moderately at the proximal end, is elongated, and terminates distally in a rounded trochlear end identical with that of birds, and apparently similarly formed by the anchylosed tarsal bone (Pl. XI. fig. 8, *a*). This may be seen in *Dimorphodon* (Pl. XI. fig. 8) and in many Ornithosaurs from Solenhofen, though the tarsal element is occasionally unanchylosed, as in young birds. This point has some interest, since the blending of the tibia and tarsus is one of the strongest points in Prof. Huxley's definition of a bird. And it seems to assist in modifying Prof. Huxley's assertion that the pes is a part of the skeleton in which birds and Ornithosaurs diverge most widely.

The metatarsal bones of Ornithosaurs are perhaps the most variable part of the skeleton. They appear to have been applied to the ground as in unguiculate mammals and reptiles, sometimes to have diverged widely, and sometimes to have been packed close together as in *Dimorphodon*. There is no evidence that they became anchylosed into one mass in any species; but, on the other hand, the evidence is not perfectly satisfactory that the metatarsal bones were anchylosed in *Archæopteryx*.

Ornithosaurs have either four or five toes, in which the phalanges appear usually to successively increase in number as in birds and lizards. The claws also are large and compressed from side to side as in lizards and birds.

Thus in the hind limb there is no structure which can be regarded as truly reptilian, though the separation of the metatarsal bones, taken together with the number of phalanges in the digits, is a closer resemblance to reptiles than to birds. But the partial separation of the metatarsals in the Penguins seems to indicate that total separation of the bones would not be inconsistent with avian structure.

From this review of the osteology of this group of animals, it seems to follow:—

(1) that the reptilian hypothesis of their structure, though not without some interesting indications, especially in the vertebral articulation, is in general so unsupported and so opposed to facts that it must be regarded as no longer tenable.

(2) That if the pneumatic foramina and cerebral structures had

remained unknown, the forms of the bones would have been sufficient to show that in their osteology Ornithosaurs resemble birds more closely than other animals; and that the differences from birds in osteology are much less than the differences between the several orders of mammals or of reptiles.

(3) That the resemblances to reptiles do not necessarily indicate genetic affinity with reptiles, any more than the resemblances to mammals indicate mammalian affinities; and that it is more than probable that both kinds of resemblances are to be ranked among the ordinal rather than with the class characters of the group.

(4) That the osteology, being largely avian, is in entire harmony with the indications of the soft organs, and justifies the conviction that the pneumatic foramina seen in the bones served identical purposes in living birds and in these animals, and therefore that Ornithosaurs form a group of birds which bears relation to existing birds such as the Chelonia hold to the Crocodilia among reptiles. That is, Pterodactyles are birds in the large sense of the term, in some respects much more reptilian than any birds which now survive.

Hereafter perhaps it may be found desirable to group Ornithosaurs with the Dinosauria and Dicynodontia in the class Palæosauria instituted by Von Meyer for those extinct orders which hold places intermediate between the higher vertebrata; but in the mean time they may well rest near to birds.

DESCRIPTION OF PLATE XI.

Fig. 1. Brain of Owl (*Strix otus*), seen from above, after Leuret.

Fig. 2. Natural mould of the upper part of the brain-cavity of an animal from the Cambridge Upper Greensand, referred to *Ornithocheirus*, showing the cerebellum (*cm*) between and behind the cerebral hemispheres. Portions of the cranial bones in the squamosal regions (*s*) are left attached to the mould. Nat. size.

Fig. 3. Inferior aspect of the same specimen, showing the oblong mass of the cerebellum (*cm*) extending between (*s*) the lateral bones of the hinder part of the brain-case and (*e*) the back of the orbit of the eye. Nat. size.

Fig. 4. Transverse vertical section through the parietal segment of the skull of an *Ornithocheirus* in the Woodwardian Museum, showing the position of the optic lobes (*o*) relatively to the cerebrum (*c*).

Fig. 5. Transverse vertical section through the skull of an owl in the parietal region, for comparison with the preceding figure of an Ornithosau-

rian. In all these figures, *c*, cerebrum; *o*, optic lobe; *cm*, cerebellum; *s*, squamosal region.

Fig. 6. Vertical diagram of the carpus of *Ornithocheirus*, for comparison with fig. 7.

Fig. 7. Vertical diagram of the carpus of an Ostrich (*Struthio camelus*). In these figuers, *p*, lateral carpal; *q*, proximal carpal; *r*, distal carpal.

Fig. 8. Tibia and fibula of *Dimorphodon* from the Lias, from a photograph of a specimen in the British Museum: *t*, tibia; *f*, fibula; *a*, anchylosed tarsal element. $\frac{3}{4}$ nat. size.

Fig. 9. Diagram outline of proximal surface of distal carpal of *Ornithocheirus*, showing separation into:—*m*, magnum; *td*, trapezoid; *u*, unciform.

Fig. 10. Diagram of distal surface of same distal carpal, showing *pn*, deep pneumatic foramen at the confluence of the three bones, and outlines of the positions of articular surfaces for three metacarpal bones. The evidence for these diagrams is in the Woodwardian Museum.

Fig. 11. Longitudinal section of a tooth of *Ornithocheirus*, curved from end to end, showing close-set radiating calcigerous tubes. Enlarged $\frac{3}{1}$.

Fig. 12. Transverse section from the base of the crown of a large tooth of *Ornithocheirus* from the Cambridge Upper Greensand. Enlarged $\frac{3}{1}$.

Notes upon the Oxystomatous Crustacea.
By Edward J. Miers, Esq., F.L.S.

[Read June 15, 1876.]

(Abstract.)

In this paper (which will be published shortly in the Society's Transactions with illustrations) the author first enters into the literature of the subject, and then gives descriptions of species of the family Leucosiidæ.

Of the genus *Leucosia* there are in the British Museum eight species hitherto unrecorded; and these are now named and may be enumerated as follows:—

L. fusco-maculata.	*L. reticulata.*
L. pulcherrima.	*L. whitmeei.*
L. affinis.	*L. perryi.*
L. brunnea.	*L. pubescens.*

A variety of *Myra mamillaris*, Bell, is noted, possibly an immature example; and he suggests that the *M. carinata* and *M. elegans* of Bell may turn out not to be adult animals.

Nursia sinuata is referred to as a new Australian form; and comparisons between what have been termed *N. plicata*, *N. abbreviata*, and *N. hardwickii* are instituted. *Arcania granulosa* and *Cryptocnemius holdsworthi*, respectively from Australia and Ceylon, are considered among the new species.

The family Matutidæ is next treated of, and subsequent to a historical summary a revision of the species of the oriental genus *Matuta* completes the paper. Formal reference to nine species of the genus is made, and others are more or less incidentally mentioned. Five new species of *Matuta* are described, viz.:—

M. rubro-lineata. *M. maculata.*
M. lineifera. *M. obtusifrons.*
M. granulosa.

On the Prehistoric British *Sus*.

By Professor G. Rolleston, F.R.S., F.L.S., &c.

[Read June 15, 1876.]

(Abstract.)

This memoir will be printed in the Society's Transactions in full.

The following specimens were exhibited at the Meeting:—1. Skull of *S. scrofa*, var. *domesticus*, from a late Celtic interment. 2. Skulls of *S. scrofa*, var. *ferus*, from alluvium near Oxford and from Germany. 3. Skull of *S. andamanensis*, forwarded to the Author by J. Wood Mason. 4. Skull of *S. cristatus*, lent by Sir Walter Elliot, K.C.S.I. 5. Skull of *S. barbatus*, wrongfully named *S.verrucosus*, and needlessly *Euhys barbatus* in some mammalogical catalogues.

Upon these and other data the author bases the subjoined conclusions:—

1. The domesticated pig of pre-Roman times, at least as exemplified by the specimens from the interment referred to, appears to resemble *S. scrofa*, var. *ferus*, rather than *S. cristatus* or the domestic variety, *S. indicus*.

2. On the other hand, *S. cristatus*, the Indian wild hog, appears to him, whilst being readily and always distinguishable from *S. scrofa*, var. *ferus*, to differ from it mainly by the retention permanently of certain structural conformations which were only temporarily represented in the European wild species. The third molars of the male *S. cristatus* varied, however, concomitantly with its canines, and showed a much larger development of their posterior lobe than either *S. scrofa*, var. *ferus*, or the females of their own species. The rearmost lobe, however, of the posterior

molar varies a good deal in *S. scrofa*, var. *ferus*, irrespective of sex.

3. Bearing in mind the elasticity of the swine type and the power for changing which their domestication has shown them to possess, Dr. Rolleston has less difficulty in conceiving that the so-called *S. indicus* was really a modified *S. cristatus*, than that it had been evolved from any *Sus* (such as *S. leucomystax*) from countries further away from Europe than India. *S. cristatus* had the malar border of the lachrymal always marked by the relative shortness insisted on by Nathusius. It had not the relatively wider palate; but upon this point too much weight had been laid.

4. A skull of a wild sow from the alluvium, later in date than the "river-gravel," near Oxford, combined the short lachrymal characteristic of young pigs and of *S. cristatus* with the worn-down teeth, elongated facial skeleton, and disproportionately small size of an old wild sow (*S. scrofa*, var. *ferus*). Such a combination of characteristics tended to suggest carefulness as to accepting the Torf-Schwein (*S. scrofa*, var. *palustris*) of Rütimeyer as a distinct species, or taking even such a point as the shortness of the lachrymal as constituting a specific difference.

5. The simplicity of the third molars in the very large skull of *S. barbatus* appears to be of greater value, as the rugose condition might have been expected to be forthcoming in so large, so well-armed, and so well-fed a *Sus* as this from Borneo.

6. The true *S. verrucosus* differs from *S. barbatus* in having the lachrymal's malar edges long, relatively to its orbital, as well as in the peculiarities which its specific name implies. These peculiarities were reproduced in the old Irish "Greyhound Pig," figured by Richardson, 'Domestic Pigs,' p. 49, ed. Warne.

7. The often quoted paper by Dr. Gordon, 'Medical Times and Gazette,' May 2, 1857, p. 429, led us to suppose that *Tænia solium* of man infested the domestic pig of India, as it does those of other parts of the world. The facility with which the pig lends itself to domestication enables us to understand how the many-sided commensalism which now exists between man and that animal may have set up in very early times. Indeed the particular result of their commensalism which their solidarity as regards the alternations of the generations of *Tænia solium* represents, suggests that their coexistence in time must have been more extensive than even the coexistence in space ascribed to them, not quite correctly, by Gibbon ('Decline and Fall,' chap. ix. note 9, p. 392, Smith's edition).

On some Irish *Gasterostei*.

By Francis Day, F.L.S., F.Z.S., &c.

[Read November 2, 1876.]

The following short remarks on some Irish Sticklebacks are based upon a small collection of fish which I made in June this year whilst with Dr. Dobson at Edgeworthstown (county of Longford), Ireland.

My attention had been drawn to Dr. Sauvage's interesting revision of the family Gasterosteidæ (' Nouvelles Arch. du Mus. d'Histoire Naturelle,' 1874), which I had with me, and wherein he augments the species resident in Europe from seven (as given in the ' Catalogue of Fishes of the British Museum' in 1859) to seventeen. Dividing the genera into three subgenera, he attaches considerable prominence to the presence or absence of plates along the sides, whilst the character of the pubic bone is deemed of sufficient importance to form a subgenus upon it. I wished to test his conclusions by fresh specimens; and if results tend to throw doubt upon some of his admitted species, it must be remembered that my facts have been collected subsequent to the publication of the memoir alluded to.

Abnormal variations of form or structure in single specimens, of course, are not of the same importance in zoology as abnormal variations or varieties of species due to local influences. The *first* may be accidental, as owing to injury in the specimen; the *second* has some local cause at work, the action of which is more or less apparent in the whole of the members of the species. When such local effects can be ascertained, they are interesting; where the cause can be shown, doubly so; for a local cause may have a wider signification than is at first apparent.

Some fishes doubtless show a greater proclivity to abnormal deviations from the original type than others. Thus the Perch (*Perca fluviatilis*) is not considered to be subject to any considerable variation in the normal number of its dorsal spines and rays; on the other hand, the contrary is observable in the majority of the East-Indian freshwater Acanthopterygian forms.

Much stress has been laid in ichthyology on the presence or absence of ventral fins. Irrespective of the apodal fishes, we have, amongst the Acanthopterygians in the family Ophiocephalidæ, the genus *Channa*, separated from *Ophiocephalus* owing to its

wanting ventral fins, which, however, are but indifferently developed in the latter genus. For the same cause, amongst the Siluridæ, *Ailichthys* is separated from *Ailia*. In the Cyprinodontidæ *Tellia* is a *Cyprinodon* deficient in ventrals. In the Cyprinidæ, subfamily Cobitidina, *Apua* is closely allied to *Acanthophthalmus*, but has no ventrals; whilst one of the chief differences between the Clupeoid *Opisthopterus* and *Pellona* is that the former is without ventrals, whilst the latter has only small ones*.

Amongst a number of Sticklebacks (Gasterosteidæ) obtained in Ireland were two very distinct species. The one was bright pink on the chest and along the under surface of the body; whilst the second or more elongated form was of a dull cobalt-blue on the head and chest †. The pink ones had three or four serrated dorsal spines; the blue ones from two to nine smooth spines, and were either without or with small ventral fins.

Had I merely captured specimens of this little species (destitute of ventral fins), I might have been induced to believe that I had discovered a novel subgenus of *Gasterosteus*. But as specimens came to light demonstrating that the ventral spine might be present, and this not due to age or sex, the fact became obvious that the presence or absence of this fin in *Gasterosteus* is insufficient even to characterize a species. And when one considers that the comparative length of the ventral spine to the pubic plate is still looked upon by some ichthyologists as a good diagnostic signification of a species, one is tempted to question the correctness of such a proposition.

Before entering upon the description of the fishes obtained, it

* Respecting the marine fifteen-spined Stickleback, Couch remarks of the development as follows:—"At the precise time of quitting the egg the young were placed under a magnifier of moderate power, when it was observed that . . . . the belly was protuberant, and in some the ovum was still visibly attached to the body, and, as the point of union was diaphanous, globules could be seen that had passed from the egg to the intestine. No ventral fins could be perceived, which is less a matter of surprise that it has been observed in other instances; these organs are the last that go through the process of development" (Fish. British Islands, vol. i. p. 183).

† Newman observes, 'The Fishes of Scandinavia,' that the *G. pungitius*, or "sma sprigg" of Sweden, during the breeding-season, is coloured red about the lower jaw, cheeks, gill-cover, and base of the pectoral. Those I obtained in Ireland were breeding, and of a colour as described above.

may not be amiss to point out that the Acanthopterygian, or spiny-rayed, fishes appear to be most numerous in the ocean (preying upon their articulated-rayed neighbours the Clupeidæ &c.); but as we examine waters more inland, the Salmonidæ or Cyprinidæ usurp their place, these latter not being possessed of spinate, but merely articulated rays. A maritime residence appears most adapted for the Acanthopterygian or spiny-rayed fishes; a fresh-water inland one to the Malacopterygian, or spineless forms. The family Gasterosteidæ, however, are found in both localities, and, being so, are well worthy of particular attention.

M. Blanchard observes of the Gasterosteidæ, that it is in the vicinity of the coast that we find the species in which the armature is most largely developed, whilst those having the free portion of the tail unarmed are met with at the greatest distance inland.

The single known marine species *G. spinachia* has about fifteen dorsal spines, whilst laterally the body is covered with plate-like scales. In the inland forms we do not find such a numerous development of the dorsal spines. The *G. pungitius* to which I shall have to allude, is possessed of the most (or nine) spines; but these may be materially reduced in number, as to four, or even to two; whilst its ventral spine may be entirely wanting, owing to a non-development of the pubic plate.

Amongst the fishes which I obtained were the following:—

GASTEROSTEUS PUNGITIUS, *Linnæus, Yarrell, Günther, Couch, &c.*

Length of head $3\frac{3}{4}$ to $4\frac{1}{3}$, of caudal $5\frac{2}{3}$ to $7\frac{1}{4}$; height of body $5\frac{1}{4}$ to $6\frac{1}{4}$ in the total length. *Eyes*, diameter $3\frac{1}{4}$ to 4 in the length of head, one diameter from the end of snout, and also apart. The maxilla extends posteriorly to below the front edge of the eye. *Fins*, first eight dorsal spines of varying length, but low, being about half the height of the rays, all smooth, the last being invariably the longest; caudal slightly lobed. Ventrals entirely absent in eleven out of thirteen specimens, whilst the pubic plate was also deficient.

Out of 13 specimens varying from 1·4 inch to 2·1 inches in length were the following:—

2 specimens, each 1·7 inch long	D. 9/9, P. 10, V. 1. A. 1/9, C. 12.
9 specimens, from 1·4 to 1·9 inch long ...	D. 8–9/9–10, P. 10, V. 0, A. 1/9–10, C. 12.

1 specimen 2·1 inches long	D. 4/10, P. 10, V. 0, A. 1/9, C. 12.
1 specimen 1·6 inch long..................	D. 2/9, P. 10, V. 0, A. 1/9, C. 12.

In the specimen with only two dorsal spines the seventh and ninth were visible, the remainder not appearing above the integument.

In examining the specimens wherein ventral spines existed, they, as a rule, were not one half the length of the pubic plate; in one specimen the spine on one side of the body was one third shorter than its fellow on the opposite. In those wherein no ventral spines existed, the pubic plate was also absent, and, as a natural result, the spines which arise from it were likewise deficient.

Further extended investigations are necessary to solve the question, whether these fishes which are resident far inland are subject to an arrest of development in their ventral spines and pubic bones, or whether those which live nearest the coast have, as a consequence, an increased development of offensive or defensive armature.

Diagrams of Stickleback and ventral plates.

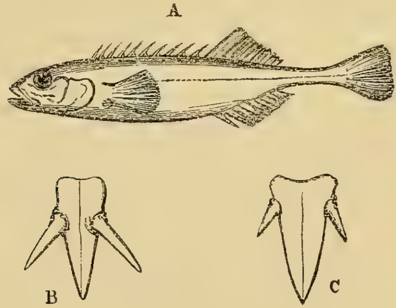


Fig. A, abnormal example of *Gasterosteus pungitius*; B, ventral spines &c. of specimen of *G. aculeatus*; C, ventral spines &c. of second specimen of *G. aculeatus*.

G. ACULEATUS, *Linnæus, Yarrell, Günther, Couch, &c.*

D. 3–4/11–12, P. 10, V. 1/1, A. 1/8–9, C. 12.

Without entering into any detailed description of the fish of this species or its synonymy, I will merely advert to such varieties as were captured. Out of upwards of two hundred specimens, none

were deficient of any portion of the pubic arch; but the triangular pubic plate differed both in its form and size. The height of the dorsal spines was subject to great variation, and the comparative length of the ventral spine to the pubic plate was inconstant, these variations not being due to the size of the specimens (see figs. B and C).

The lateral scale-like plates were either three long ones articulating with the ventral plate, or else a fourth and even a fifth were also present—this being an advance towards the variety *trachurus*, wherein these plates are found along the whole length of the body of the fish.

Those with three dorsal spines had the first two from $1\frac{2}{3}$ to 2, $2\frac{1}{3}$, and 3 times in the height of the body; those with four spines had the second 2 to $2\frac{1}{4}$ and $2\frac{1}{2}$ in the height of the body. This species appears to be subject to various deviations from the type, seen in the greater or less amount of scaly plates along the sides, and in the difference observed as to the comparative length of the ventral spine to that of the pubic plate. Desirous, however, of testing these questions, I examined numerous specimens of this fish captured at the same place; and they give the following results:—

As an average, specimens

2·4	inches long,	ventral	spine	from	$\frac{3}{4}$ to $\frac{5}{6}$	length of pubic	plate,
2·2	„	„	„	„	$\frac{5}{6}$	„	„
2·1	„	„	„	„	$\frac{2}{3}$ to $\frac{4}{5}$	„	„
2·0	„	„	„	„	$\frac{3}{4}$	„	„
1·5	inch	„	„	„	$\frac{3}{4}$	„	„

If we turn to the definition of this species, we find the ventral spine given as nearly or quite as long as the pubic plate.

There were other variations likewise perceptible in these Irish specimens: in some the ventral spine was serrated on both sides, in others only externally; the dorsal spines were likewise much less serrated in some than in others. But to me all appear to be varieties of one species; and if such can be discovered in so limited an extent of country, one cannot but surmise that a search through an extended area might be productive of greater results, and occasion the suppression of several, at present, recognized species.

Descriptions of two new Lepidopterous Insects from Malacca.

By Arthur G. Butler, F.L.S., F.Z.S.

[Read November 2, 1876.]

The British Museum has recently been presented, by Captain Stackhouse Pinwill, with a fine collection of Lepidoptera from Malacca and Penang, a complete list of which I hope shortly to have the pleasure of laying before the Society for publication; in the meanwhile I am anxious to secure to the National Collection the types of two of the finest novelties, and therefore hasten to describe and name them.

Thaumantis pseudaliris, n. sp.

♂ differs from *T. aliris* ♂ (Borneo) in having the band of primaries half the width, not notched, yellower, and terminating upon the outer instead of the inner margin; the basal area of all the wings and the body distinctly ferruginous; below, the area beyond the band of primaries is uniformly ferruginous, like the outer border, not striated; outer border paler externally, shortened by the obliquity of the transverse band; basal spots ferruginous instead of reddish brown and black; the irregular band of secondaries paler and much more constricted in the centre; the external and discal areas altogether paler and more uniform in tint, the ocelli very much smaller and paler; the spots between the ocelli and the yellow submarginal spots obsolete: expanse of wings 4 inches 7 lines.

♂ Malacca (*Pinwill*).

Professor Westwood seems to have noted this species as the male of his *T. aliris* (Trans. Ent. Soc. n. s. vol. iii. p. 176, 1856–1858); but as he figures the female of the Bornean species from an example in his own possession, the latter must be considered his type.

Amesia pexifascia, n. sp.

♀. Primaries rich purplish chocolate; external two fifths covered by a broad, externally deeply dentate-digitate, snow-white band, interrupted by the black nervures, the portion filling the end of the discoidal cell divided longitudinally so as to form two large spots; secondaries almost exactly as in *A. euplœoides*, but the anal angle deep greenish grey; body deep purplish chocolate, the last three segments of the abdomen green; palpi, tegulæ, and thorax dotted with lilacine; primaries below as above, excepting that there are a basal white spot, two costal, two subcostal, two discoidal, and two interno-

median blue-edged white spots; secondaries below nearly as in *A. euplœoides*, but the anal angle grey; body below brown, with lateral blue-edged white spots: expanse of wings 3 inches 11 lines.

♀ Malacca.

On new Species of the Genus *Euptychia*, with a tabular view of those hitherto recorded. By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

[Read November 2, 1876.]

(PLATE XII.)

WHEN I first began to study this group of Butterflies, only seventy-one species were catalogued; several of these, however, upon careful examination, proved not to be congeneric. My monograph of *Euptychia*, read before the Zoological Society in 1866, added sixty new species; and a supplementary paper which appeared in the following year added ten more.

Since the appearance of my memoir on the genus, the number of species has gradually increased to 179; it is therefore only natural that the determination of the novelties which still continue to arrive from all parts of Tropical America, should have become a laborious operation. Whilst adding to this trouble by making known to science several interesting species from the collections of Dr. Staudinger and Mr. Osbert Salvin, I propose to counteract it in a great measure by grouping the allied forms together and presenting them in a tabular form for the sake of easy reference.

Genus EUPTYCHIA, *Hübner*.

Specific name.	Author.	Where figured, or (if not figured) where first described.	Typical localities.
		E. ocirrhoë group.	
Ocirrhoë......	Fabricius ..	Sulzer, Gesch. Ins. pl. 17, figs. 3, 4 (*P. hesione*)	Central Amer.
Lydia	Cramer	Pap. Exot. ii. pl. 148, figs. C, D (1779).	Surinam.
Calpurnia	Felder......	Reise Nov. iii. p. 484 (1867) ..	Cayenne.
Metaleuca	Boisduval ..	Lép. Guat. p. 63 (1870) = *E. Butleri*, Distant.	Guatemala.
Languida	Butler......	Ann. & Mag. Nat. Hist. viii. p. 282 (1871).	Bogota.

Specific name.	Author.	Where figured, or (if not figured) where first described.	Typical localities.
		E. mollina group.	
Mollina	Hübner	Sml. exot. Schm. Zutr. figs. 105, 106 (1806).	Amazons.
Hilara. ..... }	Felder......	Reise Nov. iii. p. 485 (1867).	Bogota.
Mollis ...... }	Staudinger..	Zool.-botan. Ges. Wien. p. 105 (1875).	Chiriqui.
Insolata	Butler and Druce	Cist. Ent. i. p. 99	Costa Rica.
Westwoodii ..	Butler......	Proc. Zool. Soc. pl. 12, fig. 3 (1867).	Honduras.
Jesia	Butler......	Lep. Exot. pl. iv. fig. 6 (1869).	Ecuador.
Enyo	Butler......	P. Z. S. pl. 39, fig. 22 (1866) ..	Cuenca.
Fetna	Butler......	Ent. Mo. Mag. vi. pl. i. fig. 1 (1870).	San Geronimo.
Binocula......	Butler......	Lep. Exot. pl. iv. fig. 5 (1869).	Cayenne.
Macrophthalma	Staudinger..	Zool-botan. Ges. Wien. p. 106 (1875).	Chiriqui.
Francisca	Butler......	Lep. Exot. pl. xviii. fig. 4 (1870)	Ecuador.
		E. saturnus group.	
Saturnus......	Butler......	P. Z. S. pl. 39. fig. 19 (1866) ..	Venezuela.
Vesta	Butler......	P. Z. S. pl. 39, fig. 20 (1866) ..	Venezuela and Bogota.
Furina	Hewitson ..	Exot. Butt. iii. pl. 44, fig. 4 (1862) =*Jaresia*, Butl.	Tapajos.
		E. nossis group.	
Nossis........	Hewitson ..	Exot. Butt. iii. pl. 49, fig. 1 (1862).	Quito.
Albofasciata ..	Hewitson ..	Butler, Lep. Exot. pl. 18, fig. 7 (1870).	Ecuador.
		E. pronophila group.	
Pronophila....	Butler......	P. Z. S. pl. 12, fig. 20 (1867) ..	Rio Janeiro.
Abretia	Capronnier..	Ann. Soc. Ent. Belg. xvii. pl. 1, fig. 6 (1874).	Valença.
		E. liturata group.	
Ashna........	Hewitson ..	Butler, Lep. Exot. pl. 18, fig. 6 (1870).	Ecuador.
Liturata	Butler......	P. Z. S. pl. 12, fig. 18 (1867) ..	—— ?
Vesper	Butler......	P. Z. S. pl. 12, fig. 19 (1867) ..	—— ?
Armilla......	Butler......	P. Z. S. pl. 12, fig. 21 (1867) ..	Minas Geraes.
		E. ocypete group.	
Ocypete	Fabricius ..	Gen. Ins. Mant. p. 260 (1776)..	Surinam.
Terentia......	Felder......	Reise Nov. iii. p. 483 (1867) ..	Cayenne.
Labè	Butler......	Ent. Mo. Mag. 6, pl. i. fig. 2 (1870).	Veragua and Guatemala.
Helle	Cramer	Pap. Exot. iii. pl. 194, figs. F, G (1872).	Surinam.

Specific name.	Author.	Where figured, or (if not figured) where first described.	Typical locality.
Myncea	Cramer	Pap. Exot. iii. pl. 293, fig. C (1782).	Surinam.
Palladia	Butler......	P. Z. S. pl. 39, fig. 21 (1866) ..	Tapajos.
Terrestris	Butler......	P. Z. S. pl. 39, fig. 1 (1866) ..	Pará.
Penelope	Fabricius ..	(*clarissa*) Cramer, Pap. Exot. iv. pl. 293, figs. D, E (1782).	Surinam.
Themis	Butler......	P. Z. S. pl. 12, fig. 13 (1867)= ? *E. similis**.	Guatemala.
Usitata	Butler......	P. Z. S. pl. 39, fig. 2 (1866)....	Venezuela.
Undina	Butler......	(*similis* part) P. Z. S. pl. 12, fig. 13 (1867).	Nicaragua.
Pieria	Butler......	P. Z. S. pl. 39, fig. 3 (1866)....	Honduras.
Austera	Butler......	P. Z. S. pl. 39, fig. 4 (1866)....	Bogota.
Divergens	Butler......	P. Z. S. pl. 40, fig. 3 (1866)....	Rio Negro.
Eurytus	Fabricius ..	Syst. Ent. p. 487 (1775)	United States.
Periphas	Godart	Enc. Méth. ix. pp. 465 and 495 (1819).	Brazil.
Lethe	Butler......	P. Z. S. pl. 12, fig. 1 (1867) ..	Venezuela.
Argante	Cramer	Pap. Exot. iv. pl. 264, figs. C, D (1781).	Surinam.
Erigone	Butler......	P. Z. S. pl. 39, fig. 5 (1866) ..	St. Paulo.
Argyrospila ..	Butler......	P. Z. S. pl. 11, fig. 12 (1867)..	Ega.
Crantor	Fabricius ..	Ent. Syst. iii. p. 158 (1793)† ..	——?
Ocnus........	Butler......	P. Z. S. pl. 11, fig. 8 (1867) ..	Amazons.
Eriphule......	Butler......	P. Z. S. pl. 39, fig. 6 (1866) ..	Pernambuco.
Electra	Butler......	P. Z. S. pl. 39, fig. 7 (1866) ..	Bahia.
Variabilis	Butler......	P. Z. S. pl. 39, fig. 8 (1866) ..	Pernambuco.
Disaffecta	Butler and Druce.	P. Z. S. p. 336 (1874)	Costa Rica.
Angularis	Butler......	P. Z. S. pl. 12, fig. 8 (1867) ..	Minas Geraes.
Straminea	Butler......	P. Z. S. pl. 12, fig. 9 (1867) ..	Minas Geraes.
Affinis........	Butler......	P. Z. S. pl. 39, fig. 9 (1866) ..	Pernambuco.
Vestigiata	Butler......	P. Z. S. pl. 12, fig. 17 (1867)..	Minas Geraes.
Ochracea	Butler......	P. Z. S. pl. 11, fig. 5 (1867) ..	Brazil.
		E. renata group.	
Renata .... }	Cramer	Pap. Exot. iv. pl. 326, fig. A (1782).	Surinam.
Celmis .... }	Godart	Enc. Méth. ix. pp. 463 & 489 (1819).	Brazil.
Phronius	Godart	Enc. Méth. ix. pp. 466 & 496 (1819).	Brazil.
Pæon	Godart	Enc. Méth. ix. pp. 464 & 498 (1819).	Brazil.

* Mr. Salvin tells me that *E. similis* is distinct; but I have not had an opportunity of comparing the two types.

† Donovan's figures are not trustworthy; and therefore I do not quote them.

Specific name.	Author.	Where figured, or (if not figured) where first described.	Typical localities.
		E. grimon group.	
Marmorata....	Butler......	P. Z. S. pl. 40, fig. 1 (1866) ..	Rio Janeiro and Rio Grande.
Grimon	Godart	Enc. Méth. ix. pp. 464 & 490 (1819).	Brazil.
		E. ambigua group.	
Ambigua	Butler......	P. Z. S. pl. 39, fig. 10 (1866) ..	Rio Janeiro.
Modesta......	Butler......	P. Z. S. pl. 12, fig. 12 (1867) ..	Pará.
Hübneri	Butler......	P. Z. S. pl. 39, fig. 11 (1866) ..	Pará.
		E. hermes group.	
Galesus	Godart	Enc. Méth. ix. pp. 465 & 496 (1819).	Brazil.
Melobosis	Capronnier..	Ann. Soc. Ent. Belg. xvii. pl. i. fig. 5 (1874).	Chapeo d'Uvas.
Camerta......	Cramer	Pap. Exot. iv. pl. 293, fig. F (1872).	Surinam.
Umbrosa	Butler......	Lep. Exot. pl. xviii. fig. 8 (1870).	Ecuador.
Undulata	Butler......	P. Z. S. pl. 39, fig. 13 (1866)..	Pará.
Atalanta .... }	Butler......	P. Z. S. pl. 39, fig. 12 (1866)..	Venezuela.
Fallax...... }	Felder......	Wien. ent. Mon. vi. p. 177 (1862).	Rio Negro.
Hermes .... }	Fabricius ..	Ent. Syst. iii. p. 158 (1793)....	Brazil.
Sosybius....	Fabricius ..	Ent. Syst. iii. p. 219 (1793)....	—— ?
Maimounè	Butler......	Ent. Mo. Mag. 6, pl. 1, fig. 4 (1870).	Pebas.
Pimpla	Felder......	Wien. ent. Monatschr. vi. p. 177 (1862).	Rio Negro and New Granada.
Binalinea	Butler......	P. Z. S. pl. 39, fig. 14 (1866) ..	Kerguelen and Pernambuco.
Poltys........	Prittwitz....	Stett. Ent. Zeit. p. 311 (1865).	Corcovado.
Acmenis	Hübner	Zutr. figs. 233, 234 (1806)	Baltimore.
Zeredatha	Butler......	Lep. Exot. pl. iv. fig. 3 (1869) ..	Rio.
Eoüs	Butler......	P. Z. S. pl. 39, fig. 15 (1866) ..	Pará.
		E. phares group.	
Epinephele....	Felder......	Reise der Nov. Lep. iii. p. 476 (1867).	Mexico.
Jovita........	Felder......	Reise der Nov. Lep. iii. p. 477 (1867).	Bogota.
Phares	Godart	Encyc. Méth. ix. pp. 464 & 491 (1819).	Brazil.
Rubricata	Edwards....	Trans. Amer. Ent. Soc. (1871).	Texas.
Pharella	Butler......	P. Z. S. pl. 39, fig. 16 (1866)..	Rio Janeiro.

Specific name.	Author.	Where figured, or (if not figured) where first described.	Typical localities.
		E. harmonia group.	
Gulnarè	Butler	Ent. Mo. Mag. vi. pl. 1, fig. 3 (1870).	Panama.
Harmonia	Butler	P. Z. S. pl. 39, fig. 17 (1866) ..	Quito.
Yphthima	Felder	Reise der Nov. Lep. iii. p. 481 (1867).	Bahia.
Phineus	Butler	P. Z. S. pl. 39, fig. 18 (1866) ..	Venezuela.
Nebulosa	Butler	P. Z. S. pl. 12, fig. 2 (1867)....	Venezuela.
Oreba	Butler	Ent. Mo. Mag. vi. pl. 1, fig. 7 (1870).	—— ?
		E. necys group.	
Obscura	Butler	P. Z. S. pl. 11, fig. 9 (1867) ..	Bolivia.
Necys	Godart	Enc. Méth. ix. pp. 466 & 511 (1819) = vastata, *Butl.*	Brazil.
Squamistriga ..	Felder	*Zabdi*, Butler, Lep. Exot. pl. iv. fig. 7 (1869).	Mexico.
Rustica	Butler	Cat. Sat. pl. 1, fig. 4 (1868) ..	Bolivia.
Polyphemus ..	Butler	P. Z. S. p. 488, pl. 12, fig. 5 (1867).	Bogota.
		E. quantius group.	
Muscosa......	Butler	Ent. Mo. Mag. 6, pl. 1, fig. 6 (1870).	Brazil.
Quantius	Godart	Enc. Méth. ix. pp. 466 & 511 (1819).	Brazil.
Stelligera	Butler	Trans. Ent. Soc. p. 424 (1874) .	Minas Geraes.
		E. libye group.	
Antonoë	Cramer	Pap. Exot. 1, pl. 59, figs. E, F (1779).	Surinam.
Zeba	Butler	Lep. Exot. pl. iii. fig. 3 (1869) .	Pebas.
Sabina	Felder......	Reise der Nov. Lep. iii. p. 483 (1867).	Cayenne.
Satyrina .... }	Bates	Ent. Mo. Mag. 1, p. 179 (1865) .	Guatemala.
Gigas ...... }	Butler	P. Z. S. pl. 40, fig. 7 (1866) ..	Mexico.
Tiessa	Hewitson ..	Butler, Lep. Exot. pl. 18, fig. 4 (1870).	Ecuador.
Libye ...... }	Linnæus....	Syst. Nat. ii. p. 772 (1766)	West Indies, 'India,' *Linn.*
Libyoidea .. }	Butler	P. Z. S. pl. 11 fig. 13 (1867) ..	Nicaragua.
		E. pacarus group.	
Saundersii	Butler	P. Z. S. pl. 40, fig. 17 (1866) ..	Ega, Pernambuco.
Mima	Butler	P. Z. S. pl. 12, fig. 7 (1867) ..	Tapajos.
Fumata	Butler	P. Z. S. pl. 12, fig. 14 (1867) ..	—— ?
Pacarus	Godart	Enc. Méth. ix. pp. 465 & 495 (1819).	Brazil.

Specific name.	Author.	Where figured, or (if not figured) where first described.	Typical localities.
Peculiaris	Butler	Trans. Ent. Soc. p. 424 (1874) .	Minas Geraes.
Insignis	Butler	P. Z. S. pl. 40, fig. 12 (1866) ..	——— ?
Erichtho......	Butler	P. Z. S. pl. 40, fig. 15 (1866) ..	Pernambuco, Rio, Ega, Pará.
		E. lea group.	
Lea..........	Cramer	Pap. Exot. ii. pl. 151, figs. C, D (1779).	Surinam.
Junia	Cramer	Pap. Exot. iv. pl. 292, figs. D, E (1782).	Surinam.
Philippa......	Butler	P. Z. S. pl. 11, fig. 3 (1867) ..	Ega.
Angelica......	Butler	Trans. Ent. Soc. p. 424 (1874)..	Rio.
		E. gera group.	
Batesii	Butler	P. Z. S. p. 493, pl. 40, fig. 16 (1866).	Tapajos.
Tricolor	Hewitson ..	Gen. Diurn. Lep. pl. 65, fig. 3 (1851).	Amazons.
Fulgora	Butler	Lep. Exot. pl. iii. fig. 4 (1869) .	Pebas.
Nortia........	Hewitson ..	Exot. Butt. iii. pl. 44, fig. 2 (1861).	Amazons.
Gera	Hewitson ..	Gen. Diurn. Lep. pl. 63, fig. 4 (1851).	Tapajos.
Metagera	Butler	P. Z. S. pl. 11, fig. 4 (1867) ..	Upper Amazons.
Hiemalis......	Butler	P. Z. S. pl. 12, fig. 4 (1867) ..	Amazons.
		E. cluena group.	
Cluena	Drury......	Ill. Exot. Ent. iii. pl. 7, figs. 5, 6 (1782).	Brazil.
		E. doris group.	
Doris	Cramer	Pap. Exot. i. pl. 8, figs. B, C (1779).	Surinam.
Glaucina......	Bates	Ent. Mo. Mag. i. p. 202 (1865)	Guatemala.
Ægrota	Butler	P. Z. S. pl. 11, fig. 2 (1867)....	Pará.
Pilata	Butler	P. Z. S. pl. 40, fig. 3 (1866) ..	Ega.
Brixiola .... }	Butler	P. Z. S. pl. 40, fig. 9 (1866) ..	Pará.
Brixius .... }	Godart	Enc. Méth. ix. pp. 464 & 490 (1819).	Brazil.
Cœlestis......	Butler	P. Z. S. pl. 40, fig. 5 (1866) ..	Ega.
Mare	Butler	Lep. Exot. pl. iii. fig. 6 (1869) .	Pará.
Cærulea	Butler	Lep. Exot. pl. iii. figs. 1, 2 (1869)	Maranham.
Cyanites......	Butler	Ann. & Mag. Nat. Hist. viii. p. 282 (1871).	Brazil.
Ziza..........	Butler	Lep. Exot. pl. iv. fig. 1 (1869) .	Pebas.
Urania	Butler	P. Z. S. pl. 40, fig. 6 (1866) ..	Cameta.
Cœlica	Hewitson ..	Butler, Lep. Exot. pl. xviii. fig. 2 (1870).	Ecuador.
Lobelia	Butler	Lep. Exot. pl. xviii. fig. 5 (1870).	Ecuador.

Specific name.	Author.	Where figured, or (if not figured) where first described.	Typical localities.
		E. mæpius group.	
Mæpius	Godart	Enc. Méth. ix. pp. 464 & 490 (1819).	Guiana.
Picea	Butler	P. Z. S. pl. 12, fig. 6 (1867) ..	Ega.
		E. doxes group.	
Junonia	Butler	P. Z. S. pl. 11, fig. 11 (1867) ..	Tapajos.
Gemmula	Butler	P. Z. S. pl. 11, fig. 7 (1867) ..	Rio Janeiro.
Doxes	Godart	Enc. Méth. ix. pp. 465 & 493 (1819).	Brazil.
Erycina	Butler	P. Z. S. pl. 11, fig. 6 (1867) ..	Brazil.
Latia	Butler	P. Z. S. pl. 40, fig. 14 (1866) ..	Bahia.
		E. arnæa group.	
Arnæa...... }	Fabricius ..	Cramer, Pap. Exot. iv. pl. 292, figs. F, G (1782) = *E. ebusa*..	Surinam.
Sericeella .. }	Bates	Ent. Mo. Mag. i. p. 202 (1865)	Guatemala.
Byses	Godart	Enc. Méth. ix. pp. 466 & 496 (1819).	Brazil.
Chloris	Cramer	Pap. Exot. iv. pl. 293, figs. A, B (1782).	Surinam.
Herse	Cramer	Pap. Exot. i. pl. 10, figs. C, D (1779).	Surinam.
Callichloris....	Butler	P. Z. S. pl. 40, fig. 10 (1866) ..	Ega.
Hewitsonii	Butler	P. Z. S. pl. 40, fig. 4 (1866) ..	Pará.
Agatha	Butler	P. Z. S. pl. 40, fig. 8 (1866) ..	Pará.
Tolumnia	Cramer	Pap. Exot. ii. pl. 130, figs. F, G (1779).	Surinam.
Ayaya	Butler ..	P. Z. S. pl. 40, fig. 11 (1866)..	Tapajos.
Iris	Felder	Reise der Nov. Lep. iii. p. 483 (1867).	Bogota.
		E. clorimena group.	
Cosmophila ..	Hübner	Zuträge, figs. 255, 256 (1806)..	Bahia.
Pagyris	Godart	Butler, P. Z. S. pl. 11, fig. 1 (1867).	Brazil.
Itonis	Hewitson ..	Exot. Butt. iii. pl. 44, fig. 3 (1862)	Pará.
Quadrina	Butler	Lep. Exot. pl. iii. fig. 5 (1869) .	Maranham.
Clorimena	Stoll	Pap. Exot. pl. 13, figs. 2, 2 *b* (1791).	Surinam.
Salvini	Butler	P. Z. S. pl. 40, fig. 13 (1866) ..	Panama.
		E. phocion group.	
Phocion	Fabricius ..	Ent. Syst. iii. p. 218, n. 683 (1793).	United States.
Pyracmon	Butler	P. Z. S. pl. 11, fig. 10 (1867)..	Mexico.
Cornelius	Fabricius ..	Hübner, Zuträge, figs. 7, 8 (1806) as *E. gemma*.	—— ?
Argentella	Butler and Druce.	Cist. Ent. i. p. 98	Costa Rica.

Specific name.	Author.	Where figured, or (if not figured) where first described.	Typical localities.
Ithama	Butler	Lep. Exot. pl. iv. fig. 4 (1869) .	Central America.
		Undetermined species*.	
Lupita	Reakirt	Proc. Acad. Phil. p. 331 (1866)	Mexico.
Alcinoë	Felder	Reise der Nov. Lep. iii. p. 477 (1867).	Bogota, Venezuela.
Sylvina	Felder	Reise der Nov. Lep. iii. p. 478 (1867).	Bahia.
Numeria......	Felder	Reise der Nov. Lep. iii. p. 478 (1867).	Bahia.
Numilia	Felder	Reise der Nov. Lep. iii. p. 478 (1867).	Bogota.
Pompilia......	Felder	Reise der Nov. Lep. iii. p. 479 (1867).	Bogota, Mexico.
Peloria	Felder	Reise der Nov. Lep. iii. p. 479 (1867).	Venezuela.
Manasses	Felder	Reise der Nov. Lep. iii. p. 479 (1867).	Bahia*.

Descriptions of new Species.

EUPTYCHIA ANACLETA, n. sp. Pl. XII. fig. 4.

Wings semitransparent, pale brown, becoming more opaque towards the outer margin, with two parallel regular central dusky bands; an ill-defined discal nebula; one ill-defined dusky subapical blind ocellus in primaries and five increasing blind ocelli in secondaries, the fifth largest, better-defined, and blackish; primaries with a dusky submarginal diffused band, secondaries with two undulated submarginal lines, distinctly separate towards anal angle, but coalescing towards apex; abdominal area of female whitish: body grey, head brown: wings below very pale grey, nearly white, crossed by three bands, the two nearest to the base red-brown, the third broader, red-brown on secondaries, more or less ochreous on primaries (entirely so in the male); two irregularly undulated submarginal blackish lines, terminating at anal angle of secondaries in two irregular orange lituræ; primaries with a large subapical black ocellus, with blue pupil and testaceous iris; below it two small ill-defined ocelli; a large diffused discal ochreous patch; subapical area dusky; a grey marginal line; secondaries with five ocelli, the fifth large, the first, second, and fifth black, with blue pupils and stramineous irides, the third and fourth dusky, with silvery pupils and pale testaceous irides; a dusky nebula round the ocelli: body below whitish: expanse of wings ♂ 1 inch 4 lines, ♀ 1 inch 5 lines.

* The species described by Felder, and here enumerated, will remain unknown to science until either proper descriptions are published, or the types can be examined.

♂ Chiriqui (*Ribbe*); ♀ Bogota (*Nolcken*). Coll. Dr. O. Staudinger.

Allied to *E. palladia*.

E. URBANA, n. sp. Pl. XII. fig. 7.

Wings above olive-brown, basal area and outer border of primaries rather darker, an undulated submarginal line and two marginal lines dark brown; secondaries with a line enclosed by the two marginal lines, testaceous at the anal angle; two oval subanal ocelli, the exterior one on the first median interspace double as large as the other, both of them black, with testaceous iris and silver pupil; body blackish: wings below paler, irrorated with dark brown; two central irregular ferruginous lines, submarginal and marginal lines as above, excepting that the line on the margin is black; primaries with the central lines divergent towards costa, the inner one angulated; a small blind subapical ocellus; secondaries with the central lines parallel, slightly irregular, the outer one feebly angulated at the end of the cell; six discal ocelli; the first, third, and fourth small, the fourth malformed, the first two and the last two black; all of them with silver pupils, broad ochraceous irides, and dusky diffused zones: body below grey; expanse of wings 1 inch 8 lines.

Columbia (*coll. Sommer*). In coll. Dr. O. Staudinger.

Allied to *E. variabilis*, but smaller, the primaries narrower and more produced.

E. SOTER, n. sp. Pl. XII. fig. 11.

Wings above pale olive-brown, slightly darker towards the base; a blackish transverse dot at the union of the upper and lower discocellulars of primaries; a dark brown zigzag submarginal line, a marginal testaceous line edged on both sides with dark brown; fringe greyish brown; primaries with a straight transverse discal dark brown line; secondaries with minute ocelli, on interno-median and first median interspaces: body blackish; wings below sandy brown, reticulated and speckled with dark brown; a central, broad, slightly irregular band darker than the ground-colour and edged on each side by a brown line; submarginal and marginal lines as above; primaries with a minute silver-pupilled subapical ocellus; secondaries with six minute discal ocelli in an irregular series, the fourth indistinct, the second and fifth with two very small silvery pupils: body below greyish; legs pale brown: expanse of wings 1 inch 7 lines.

New Friburg. In coll. Dr. O. Staudinger.

E. BENEDICTA, sp. n. Pl. XII. fig. 14.

Wings above olive-brown; outer border of primaries dusky; secondaries with two undulated darker brown submarginal lines; marginal line black: body blackish: wings below paler; two transverse rather broad central castaneous bands; a zigzag submarginal red-brown line,

beyond which is a slender, undulated, submarginal black line; outer margin black; primaries with central bands slightly divergent; three subapical discal ocelli, the uppermost black, white-pupilled, with yellow iris, the other two ill-defined; secondaries irrorated with testaceous; with six ocelli, the first, second, and fifth black, the others brown, the first and last small, the second and fifth largest, all excepting the first and last bipupillated, all with yellow irides; body below blackish: expanse of wings 1 inch 10 lines.

Sarayaco, Ecuador (*Buckley*). In coll. O. Salvin.

This species is allied to *E. hübneri*, but differs considerably, particularly in the size of the ocelli below.

E. MELCHIADES, n. sp. (Pl. XII. fig. 9.)

Dark olive-brown, with two indistinct darker submarginal lines, marginal line black; fringe grey; secondaries with two small black subanal ocelli with silver pupil and ochreous iris, the upper one about three times as large as the lower: body blackish: wings below paler, mottled all over with dark brown; two submarginal dark brown lines, the inner one irregular; margin black; fringe grey: primaries with a nearly straight transverse discal line; five small discal ocelli, the second largest: secondaries with two central, parallel, transverse, dark brown lines, the outer one undulated; six discal ocelli, the second and fifth largest, the third obliquely bifid, all black, with silver pupils and ochreous irides: pectus grey, legs testaceous, palpi white, with grey hair-scales: expanse of wings 1 inch 6 lines.

Cordova (*Berg*). In coll. Dr. O. Staudinger.

Belongs to the *E. hermes* group.

E. CALIXTA, n. sp. (Pl. XII. fig. 8.)

Wings above deep olive-brown, darker towards the outer margin; body blackish, below paler, with two central dark brown bands, two submarginal lines, the inner one undulated (especially in the secondaries), and the margin dark brown; fringe dark brown: primaries with the upper discocellular dark brown; central bands slightly divergent towards the costa; five discal ocelli, the third and fourth small and brown, the others black, the second rather larger, all with silver pupils and narrow ochreous irides: secondaries with the outer central band bisinuated, and angulated at abdominal margin; six discal ocelli, the third united to the second, it and the fourth small, brown; the first and last also small, but black, the second largest; all with silver pupils, ochreous irides, and brown zones: body below dark grey: expanse of wings 1 inch 6 lines.

Bogota (*Nolcken*). In coll. Dr. O. Staudinger.

E. FABIANA, n. sp. (Pl. XII. fig. 5.)

Wings above reddish brown; body blackish: wings below paler; two central parallel transverse dark brown lines slightly incurved, and very slightly divergent at costa of primaries; a submarginal ill-defined dark brown zigzag line: pectus dark grey, venter pale brown: expanse of wings 1 inch 11 lines.

Macahé (*Beske*). In coll. Dr. O. Staudinger.

Allied to *E. rusticana*, but without the white spot on under surface of primaries; also allied to *E. vastata*.

E. EUSEBIA, n. sp. (Pl. XII. fig. 13.)

Wings above olive-brown; body dark grey: wings below with the discal area paler, margin black, a dusky line close to the margin; primaries with a transverse arched litura beyond the cell, an irregular submarginal dark-brown line, a trace of a small subapical ocellus; secondaries with two transverse central lines, the outer one angulated, and a zigzag submarginal line, dark brown, traces of five or six small discal ocelli on a dusky nebulous band, basal area and pectus blackish; venter pale brown: expanse of wings 2 inches 3 lines.

Bogota (*Nolcken*). In coll. Dr. O. Staudinger.

Allied to the preceding species.

E. CYCLOPS, n. sp. (Pl. XII. fig. 2.)

♂. Wings above piceous brown; body blackish: wings below with two central lines, a submarginal undulated line, and two marginal lines black-brown; primaries with the central lines inarched, three subapical white dots in an angulated series, the uppermost one largest; secondaries with the central lines slightly undulated and arched, the outer one strongly angulated on the discoidal interspace; six white-pupilled black spots, all extremely small excepting the fifth, which is placed upon the first median interspace, and is large and well defined: pectus blackish, legs and venter pale brown: expanse of wings 2 inches.

♀. Rather paler and larger: expanse of wings 2 inches 3 lines.

♂, Chiriqui (*Ribbe*): ♀, Canchamayo (*Thamm.*), coll. Dr. O. Staudinger; Costa Rica (*Van Patten*), coll. O. Salvin.

Allied to *E. polyphemus*. The female has four white dots on the under surface of primaries.

E. ÆTHERIALIS, n. sp. (Pl. XII. fig. 10.)

Above cobalt-blue, like *E. ægrota* ♂, but with the inner transverse line of primaries obsolete, and the outer one much more slender, black subanal spot of secondaries smaller: wings below silvery blue, crossed by two slender parallel central rust-red lines, angulated upon abdominal margin; two submarginal lines, the inner one undulated, rust-red on secondaries, the outer one dark brown, very slender, a slender

dark-brown marginal line; primaries with three small discal ocelli, the uppermost one with yellow iris, the central one smallest and indistinct; secondaries with five ocelli, the first smallest, the first two and the last with yellow irides and white pupils, the last two with two pupils: body below bluish: expanse of wings 1 inch 7 lines.

Sarayaco, Ecuador (*Buckley*). In coll. O. Salvin.

This species, although nearly allied to *E. ægrota* from the Lower Amazons, seems to be distinct; it is altogether less heavily marked, with the ocelli below smaller and less pronounced.

E. TELESPHORA, n. sp. (Pl. XII. fig. 1.)

Wings above olive-brown, slightly darker towards the outer margins, primaries with an ill-defined darker submarginal line; secondaries with a greyish discal nebula enclosing an ill-defined dusky spot near anal angle; two submarginal lines and the fringe black-brown: wings below much like those of *E. pagyris*, but the wings narrower, outer band of primaries much less strongly arched; area enclosed by the central bands of secondaries white to the origin of the radial nervure; outer band strongly angulated, the angle being formed at the apex of the discoidal cell; outer margin of the yellow discal area much more irregular; silver spots narrower, the second from costa forming a small black ocelloid spot; the black patch on first median interspace double the width, with one large quadrate silver pupil; subanal silver spots placed obliquely to each other: expanse of wings 1 inch 8 lines.

Hab. ——? (Sommer's collection). In coll. Dr. O. Staudinger.

It is possible that this may be Stoll's *E. clorimena*; but the figure of that species is so very poor, that not knowing the habitat of *E. telesphora* I cannot consider it identical with *E. clorimena.*

E. HYGINA, n. sp. (Pl. XII. fig. 6.)

Wings above pale olive-brown; primaries with submarginal lines dimly visible through the wing; secondaries with a large pale buff discal patch, round which is a series of five blackish spots, the three smaller ones forming a triangle at its upper extremity, the two larger ones submarginal, upon the median interspaces; two zigzag submarginal blackish lines coalescing towards apex; outer border pale; margin brown: body greyish: wings below paler than above, whitish brown, markings of primaries almost as in the preceding species, but of a lighter ferruginous brown colour; secondaries with two central parallel lines, the outer one irregular, deeply excised where it crosses the cell, and widened by a tapering slightly paler ferruginous border below it; discal area whitish, as usual, with the ochreous area brightly coloured, and spotted with silver as follows—two small spots close together near apex, four larger spots forming a diamond-shaped figure

beyond the cell, a transverse ∞-shaped figure with silver centres and three silver spots towards anal angle; outer border buff-coloured, enclosed by the zigzag submarginal line as above: body greyish white: expanse of wings 1 inch 9 lines.

Hab. Brazil. In coll. Dr. O. Staudinger.

Also allied to *E. pagyris.*

E. CLEMENTIA, n. sp. (Pl. XII. fig. 3.)

♂. Wings above pale olive-brown, crossed by an ill-defined central darker line, beyond which there is a band of slightly paler colour not well defined; primaries with an indication of a submarginal line, and the margin slightly darker brown; secondaries with four smoky-brown diffused discal spots in an arched series, two zigzag submarginal dark-brown lines on a whitish-brown ground; fringe greyish brown: body dark grey, head and abdomen brownish: wings below paler, crossed by two darker lines which diverge towards the costal margins of both wings; two submarginal lines and the outer margin dark brown; discal area of primaries whitish, crossed by a transverse olive-brown band which encloses a series of ill-defined silver-dotted ocelloid spots; secondaries with the disk snow-white, crossed by a broad irregular brown-edged ochreous band, enclosing two silver-centred black ocelli towards apex (the second large) and one towards anal angle; between and beyond the ocelli some elongate silver markings: body below whitish: expanse of wings 1 inch 7 lines.

Chanchamayo (*Thamm.*). In coll. Dr. O. Staudinger.

This beautiful little species is allied to *E. cosmophila.* It is very distinct from any thing that I have seen.

PS. Since the foregoing was read and set up in type, I find that H. B. Moeschler (Verhand. Zool. Bot. Gesellsch. Wien, 1876, p. 323) describes as a new species *Euptychia nana,* from Surinam. It seems to me to be one of the many slight variations of *E. hermes.* Also (*l. c.* p. 324, tab. iii. fig. 11) *E. thalessa,* n. sp., from Surinam; this is probably an abnormal form of *E. batesii,* which it closely resembles on the underside.

EXPLANATION OF PLATE XII.

Fig. 1. *Euptychia telesphora,* p. 127.
2. —— *cyclops,* p. 126.
3. —— *clementia,* p. 128.
4. —— *anacleta,* p. 123.
5. —— *fabiana,* p. 126.
6. —— *hygina,* p. 127.
7. —— *urbana,* p. 124.

Fig. 8. *Euptychia calixta,* p. 125.
9. —— *melchiades,* p. 125.
10. —— *ætherialis,* p. 126.
11. —— *soter,* p. 124.
12. —— *galesus,* p. 119.
13. —— *eusebia,* p. 126.
14. —— *benedicta,* p. 124.

In these figures the under surface of the specimen is shown, excepting fig. 10, where the upper surface has been drawn.

Description of some New Species of Beetles (Scarabæidæ) from Central America. By D. Sharp, Esq. (Communicated by H. W. Bates, Esq., F.L.S.)

[Read November 2, 1876.]

Some little while ago, Mr. Belt placed in my hands for examination the collection of Scarabæidæ (*i. e.* Lamellicorn Coleoptera) made by him during his residence in Nicaragua, the species being, I believe, chiefly captured in the neighbourhood of Chontales. Our collections are tolerably rich in the insects of this family found in Columbia and Venezuela and the northern parts of the continent of South America, and in the Mexican species of the family; but the fauna of the intervening district of Central America is still very poorly represented in most of our British collections of Coleoptera. Mr. Belt's captures are therefore of considerable interest. On examining the Lamellicorns, I found (as was to be expected) that the species are allied to both the South-American and Mexican forms of the family, but that a considerable portion appear to be new or undescribed. The collection intrusted to me consisted of 419 individuals, representing apparently about one hundred and fifty species; and of these I consider that probably fifty or thereabouts are still undescribed. As a large number of the novelties belong to groups of which the study is attended with much difficulty (*e. g.* genera *Ancylonycha*, *Cyclocephala*, *Sphæromorphus*, *Atænius*), and are represented only by one or two individuals of each species, it would perhaps be undesirable to attempt to describe them *seriatim*; but I have selected a few species of which I think descriptions may be published with advantage. I have added also three species from my own collection from the same districts, two of which require special notice; they are the species I have called *Phalangogonia sperata* and *P. stipes*. The genus *Phalangogonia* is of special interest, owing to its differing greatly from the allied Rutelidæ found in these parts of America, and to its approaching very closely to the Australian Anoplognathi. The single species of which the genus is hitherto composed, viz. the *Phalangogonia obesa*, Burmeister, is extremely rare, and is, in fact, unknown in most even of the best collections. Burmeister described the species, apparently on a single individual, which he considered to be a male, but which, I am pretty sure, from his description, was a female. Lacordaire has figured a species in the Atlas to his 'Genera des Coléoptères,' pl. xxxv. fig. 1, which he calls *Phalangogonia obesa*, Burm.; this

figure certainly represents a female individual, and, I think, very probably a species distinct from Burmeister's *P. obesa.* Of each of the two species I here describe, I have seen but a single individual, one of which is male, the other female, the sexual disparities being remarkable: had these two individuals been found together, or in the same district, I should have considered it probable that they were the sexes of one and the same species; but as this was not the case, I have thought it better to consider them at present as two distinct species. It would appear probable, then, that *Phalangogonia obesa*, Burm., is a Mexican species, of which the female only is described, that *P. obesa*, Lacordaire (*l. c.*), is a representation of a female of an allied Mexican species, while *P. sperata*, Sharp, is a Central-American species described from a single male individual, and *P. stipes*, Sharp, is possibly only a female variety thereof.

Among the more interesting species represented in Mr. Belt's collection are:—*Megathopa candezei*, of which an admirable diagnosis has been recently given by Baron von Harold, but which, I think, would have been better treated as a distinct new genus, between *Megathopa* and *Canthon*; a beautiful *Plusiotis*, which M. Boucard calls a variety of *P. aurora*; a form allied to *Pelidnota*, and another to *Chlorota*, both perhaps really new genera, but represented only by single individuals; *Podischnus terisander*, Burm., which I have never seen before, but which undoubtedly is a distinct species from the common *P. agenor*; the very remarkable *Amblyodon nicaraguæ*, Westwood, which is the male of *Phileurus nasicornis*, Burm., or at any rate a closely allied species; a pair of the very rare *Lycomedes reichei*; a series of *Allorhina anomala*, Bates, showing that the species varies in size from 19 to 26 millims., and greatly in the development of the pale markings, the thorax being in one individual entirely bordered with a pale yellow marking; a series of *Gymnetis ramulosa*, Bates, in which the transverse pale mark of the elytra is alike in no two individuals, and shows also a sexual disparity; and a pair of the elegant *Dialithus magnificus*, in one individual the elytra being black, while in the other they are red.

Onthophagus tapirus, n. sp. Thorace in utroque sexu mutico. Subdepressus, nigro-æneus, nitidus, capite et thorace magis æneis, pedibus piceis; thorace sparsim, minus fortiter punctato, elytris evidenter striatis, interstitiis impunctatis; pygidio fortiter punctato. Long $5\frac{1}{2}$–7 millim.

Mas clypeo apice prolongato et recurvato, processu apice transversim valde dilatato, genis dilatatis; tibiis anterioribus sat elongatis.

Fem. clypeo apice acute bidentato, capite crebre sat fortiter punctato.

The antennæ are reddish at the base, with the club infuscate. The thorax is about $2\frac{2}{3}$ millims. in length, and about $3\frac{1}{2}$ broad, and is of a brilliant and shining brassy colour; it is distinctly punctured at the front angles, and more indistinctly about the middle; but on the basal portion the punctures are nearly absent. The elytra are smooth and shining, and destitute of any punctuation or pubescence. The pygidium is coarsely punctured, and bears scanty, short, stout, erect, pale setæ. The metasternum in the middle is brassy, and is only sparingly punctured; the punctures are rather coarse on its lateral parts, but indistinct elsewhere; the under surface is destitute of pubescence, except that the apical segments of the hind body bear a few setæ. The front tibiæ are distinctly quadridentate.

This is a very distinct species from any other I know; but Von Harold has recently published, under the name of *Onthophagus sharpi*, a species which appears to connect *O. tapirus* with the *O. nasicornis* group.

Two other specimens found by Mr. Belt are of a bluish-black colour, and have the clypeus in front produced into a short, broad, simple process, and are probably a distinctly allied new species.

Isonychus pictus, n. sp. Olivaceo-pubescens, elytris maculis magnis nigris, antennis rufis clava fusca, pygidio rufescente, pedibus nigris. Long. 13 millim.

Clypeus black, with a faint brassy tinge, without pubescence, but with a few erect hairs, and bearing rough elevated tubercles instead of punctures. Thorax entirely clothed with a yellowish olive pubescence, which quite conceals the sculpture. Elytra also clothed with a dense olivaceous pubescence, but with some very large and distinct black spots, three along the suture and three at the side, more or less confluent: the sculpture is concealed by the pubescence; but they are finely yet distinctly striated.

In the male the front tibiæ are slightly more slender, and the club of the antennæ more elongate, than in the female, the pygidium is rather shorter and is more closely punctured, the apical ventral segment is impressed in the middle, the impression being roughly punctured and free from pubescence.

This striking species is probably allied to *Isonychus maculatus*, C. Waterhouse, from Medellin, in Columbia.

Faula centralis, n. sp. Fusco-nigra, sericeo-opaca, pallide griseo-setosa, antennis pedibusque rufescentibus; thorace elytrisque fortiter punctatis, illo area longitudinali, his lineis duabus elevatis.

Mas major, antennis pedibusque elongatis, clypeo anterius magis reflexo et emarginato, tarsis omnibus crassioribus et subtus magis pilosis; pygidio elongato, abdominis apice deflexo-prominulo, medio late sub-impresso; corpore subtus fere opaco. Long. 12½ millim.

Fem. minor, pedibus antennisque brevibus, clypeo anterius vix emarginato, tarsis omnibus simplicibus; pygidio brevi, apice utrinque sinuato; abdomine convexo; corpore subtus nitido. Long. 9½–11 millim.

In this species the thorax is coarsely punctured, but has a central space along the middle a little elevated and free from punctures; this space is narrow and indistinct on the front part of the thorax, but is very distinct on the hinder part. With the exception of this there are no other distinct spaces on the thorax free from punctures, though the punctures are unevenly distributed: the base of the thorax is distinctly prominent on each side of the scutellum, and is also slightly prominent in the middle. The front edge of the scutellum is raised, and is emarginate in the middle; but the scutellum bears no longitudinal impression, and is more densely covered with pale setæ than are the other parts.

I have a closely allied but smaller species from Brazil, which I believe is also undescribed.

Pelidnota belti, n. sp. Elongata, angustula, viridi-ænea, supra nitidissima, nuda, subtus parcius subtiliter griseo-pubescens, femoribus nigro-viridibus, tibiis rufis apice nigricantibus, tarsis nigro-cæruleis.

Mas major, pedibus longioribus et crassioribus. Long. 21 millim., lat. 10 millim.

Head rather coarsely and closely punctured, clypeus notched in front, the notch a little deeper in the female than in the male, the side-projections in the male very slightly, in the female more distinctly, reflexed. Thorax very smooth and shining, bearing evenly scattered, distant, fine punctures. Scutellum almost impunctate. Elytra with very fine and indistinct punctures, very shining. Pygidium densely and finely rugose, opaque, clothed with a short and fine pale pubescence. Under surface greenish, clothed at the sides with a fine and scanty pale pubescence, which is very indistinct on the sides of the ventral segments. Postcoxal process of prosternum broad and short, subhorizontal. Mesosternal process elongate.

This handsome insect is allied to *Pelidnota cupripes*, but is very distinct from it or any other *Pelidnota*; and I have much pleasure in naming it in honour of its discoverer.

Obs. One of the specimens brought back by Mr. Belt is of a brassy instead of a brilliant green colour, but it otherwise does not differ.

Pelidnota prolixa, n. sp. Elongata, angusta, supra testacea, vel

castanea, pedibus antennisque concoloribus; subtus fuscula; clypeo antice obtuso; thorace margine basali argute elevato; elytris impunctatis, sat nitidis. Long. 27 millim., lat. $13\frac{1}{2}$ millim.

Head densely punctured; clypeus slightly prolonged, quite obtuse in front, and with its margin slightly reflexed. Thorax very transverse, with the basal and lateral margins acutely defined, the front margin obsolete in the middle: the surface is but little shining, and its punctuation, though rather close, is indefinite, and at the sides becomes dense, confluent, and still less distinct. The scutellum is finely but distinctly punctured. The elytra are without sculpture, but are little shining, their surface having the appearance of very delicate leather. The pygidium is densely and finely rugose, and dull. The under surface is much darker than the upper; the postcoxal process of the prosternum is elongate, subperpendicular; the mesosternal process is distinctly prominent and projects beyond the edge of the coxæ.

This species may be readily distinguished amongst its allies by its elongate form and its impunctate elytra and acutely elevated basal margin of the thorax. I think the individuals I have seen are females. The species appears best placed at present near the North-American *P. quadripunctata*, from which (independently of colour and form) it is readily distinguished by the more elongate and perpendicular postcoxal process of the prosternum.

Antichira gratiosa, n. sp. Supra læte viridis, haud metallica, subtus viridi metallescens, epipleuris cupreis; scutello minore; elytris fere impunctatis, et estriatis; pectore parcissime pubescente, lateribus fortiter strigulosis; mesosterni processu elongato, paullulum descendente, sed apicem versus fortiter recurvato. Long. corp. 25–30 millim.

Clypeus rather elongate and narrow towards the front, its front margin distinctly reflexed, obscurely truncate in the middle: the punctures on the clypeus are dense near the front, become more sparing on the posterior part, and are very fine and scanty on the vertex. Thorax short and rather small, the base in front of the scutellum truncate, but not emarginate; the surface bears a few not very distinct punctures, which towards the sides, however, are more numerous and rather more distinct. Scutellum 4–5 millims. long, and about 4 millims. broad at the extreme base. Elytra without distinct sculpture, and with only very obscure indications of striæ. Pygidium rather coarsely strigose. Underside more metallic than the upper, it being of a green colour with a distinct golden or brassy tinge, appearing at first destitute of pubescence, but bearing a few fine hairs on the sides of the metasternum. The legs are slender and concolorous with the under surface; the basal portion of the epipleuræ is of a coppery colour, and shows, therefore, a distinct contrast with the rest of the surface.

I see no indication of sexual character, except that in one individual (which is, I suppose, a male) the pygidium is rather longer and narrower.

This species is allied to *A. prasina* and *A. psittacina*, Burm.; and I have also in my collection a species of *Thyridium* from Columbia which so extremely resembles *A. gratiosa* that, without examination of its generic characters, it would be considered conspecific with the Nicaraguan insect.

PHALANGOGONIA SPERATA, n. sp. Supra fulvo-testacea, nitida, elytris pallidioribus, subtus cum pedibus chocolatina, pectore utrinque densius pubescente; elytris subtiliter punctatis; mesosterni processu sat elongato. Long. 27 millim.

Clypeus with the front margin a little rounded, densely and finely rugose, so as to be dull; the vertex sparingly punctured. Thorax on the middle very finely and very sparingly punctured, at the sides more closely punctured, but the punctures very indistinct. Elytra finely and sparingly punctured, but the punctures more distinct than those on the thorax, the punctures are not arranged in rows, and there are no striæ; but on careful examination there are seen indications of two longitudinal smooth spaces limited by fine punctures. The under surface is of a uniform chocolate-colour.

Central America. A single specimen from W. W. Saunders's collection.

The individual described is, no doubt, a male; all the tarsi are stout, and the three basal joints on the four posterior ones are densely clothed beneath with setæ; the front tibiæ are very stout, and their upper tooth obsolete, the two lower ones moderately prominent: the hind tibiæ are stout, but are not broader at the extremity than in the middle, and show outwardly only a few coarse punctures.

P. STIPES, n. sp. Supra fulvo-testacea, nitida, elytris pallidioribus, subtus rufescens, abdomine nigricante, pectore utrinque densius pubescente; elytris subtiliter punctatis, mesosterni processu sat elongato. Long. 26 millim.

Nicaragua. A single individual from the collection of W. W. Saunders.

This species is very closely allied to the preceding, and, it is possible, may prove a variety of its female; but it has the mesosternal process considerably more elongate, and the longitudinal spaces on the elytra are more distinct, the colour of the under surface is darker and less unicolorous, the ventral segments being black; the hind femora, which, like the rest of the legs, are reddish, have a black patch on the middle.

The individual described is no doubt a female; the front and middle tarsi are rather slender; but the hind ones are stout, and their basal joint is much thickened and produced at the extremity on the upperside; the front tibiæ are rather stout, their two lower teeth very large, and the upper one quite distinct. The hind legs are short but thick, their tibiæ much broader at the extremity and very coarsely punctured externally.

CYCLOCEPHALA CONSPICUA, n. sp. Rubra, fere nuda; capite, pectoris lateribus pedibusque nigris; thorace vittis duabus, elytris lateribus, fascia lata basali alteraque pone medium interrupta nigris. Long. $17\frac{1}{2}$ millim.

Head entirely black, rather coarsely punctured; clypeus short and broad, $2\frac{1}{2}$ millims. broad in the middle, $1\frac{2}{3}$ millim. long, its front margin nearly straight, being only very slightly emarginate in the middle. Thorax bright red, with a black elongate mark on each side the middle, rather sparingly but coarsely punctured, except on the middle, where the punctures are finer. Scutellum red, with a few indistinct punctures. Elytra broadly black at the base, also black at the sides, and behind the middle with a very large transverse black mark which does not reach the suture, but is joined to the lateral black. They are moderately closely, but not deeply, punctured; and the punctures leave only very indistinct traces of longitudinal spaces. Pygidium and hind body, as well as the middle of the metasternum, red. Prosternal process closely applied to the coxæ; when its apex is looked at, it appears to consist of two parts, viz. an anterior part, and a posterior part, which is crescentic and fringed behind with long hairs. In the male the front tarsi are a good deal thickened, the punctuation of the elytra is much finer than in the female, the pygidium is larger, and is nearly entirely rugose, while in the female its sculpture is much less. The female has on the edge of each elytron, behind the middle, a very small prominence.

This species is allied to the Mexican *C. picta*, Burm.; but the markings on the elytra are very different, and the clypeus is rather more developed.

C. PROBA, n. sp. Transversim convexa, picea, nitida, supra nuda; thorace elytris angustiore, lateribus pone medium subsinuatis, parce punctato; elytris fortiter punctato-striatis, punctis ocellatis: pygidio nitido, fortiter punctato. Long. 17–20 millim.

Clypeus broad and short, 3 millims. broad across the middle, $1\frac{2}{3}$ millim. long, its front margin very slightly emarginate in the middle, the front angles greatly rounded, rather closely but indistinctly punctured, the punctures obsolete towards the front. Thorax $5\frac{1}{2}$ millims. long, $7\frac{1}{2}$

millims. broad, the sides not evenly rounded, but broadest in the middle, and contracted and slightly sinuate towards the hind angles, which are obtuse but quite distinct; it is very shining, and bears sparing coarse punctures, which are largest and most distinct near the front angles, and become quite fine on the middle. Scutellum broad, very sparingly and indistinctly punctured. Elytra with rows of coarse punctures, each of which is seen on examination to consist of an outer ring, and a central portion, which generally has a minute dot in the middle. Pygidium not rugose, but coarsely punctured. Propygidium partly exposed, and coarsely and very densely punctured. Sides of the metasternum closely punctured and bearing erect hairs. Prosternal process quite perpendicular, its extremity slender and not closely applied to the legs; last ventral segment very deeply depressed at the base.

In the male the apical ventral segment is excessively short, being reduced to a mere transverse band: there is no trace of tubercle on the sides of the elytra in the female. I cannot speak of the front tarsi of the male, as they are broken off in all the specimens I have seen.

This species is allied to *C. variolosa*, Burm.

Cotinis adspersa, n. sp. Supra olivacea, opaca, squamulis albidis adspersa; subtus cuprea squamulis adspersa, et fulvo-pubescens, abdomine medio lævigato; clypeo cupreo, concavo, anterius medio reflexo, parte reflexa apice angustata; vertice carina longitudinali descendente, fulvo-pubescente, apice libero, minuto; coxis posterioribus angulo externo obtuso. Long. 22 millim.

Head on the upperside coppery, hollow, the front margin reflexed, the reflexed part short and narrow at its apex, the vertex with a strongly elevated carina, the upper edge of which is not at all flattened, and its extremity free and projecting and depressed; the sides of this carina and the parts near it are clothed with coarse, outstanding, yellow hairs. Thorax of an obscure olivaceous colour, quite dull, with some scattered rudimentary or incomplete punctures, each of which bears a coarse white scale. The base is strongly lobed in the middle, but leaves an elongate portion of the scutellum exposed. Elytra similar in colour to the thorax, with scarcely any traces of elevations (except the apical protuberance of each wing-case), and appearing at first impunctate, but really with fine scattered punctures, each of which bears an elongate white scale; these scales, however, are very easily removed. Pygidium rather densely clothed with erect narrow scales of a pale yellowish colour. Underside brassy and shining, but the ground-colour obscured by the plentiful hairs, these being particularly abundant on the front and middle femora; there are also white scales on the femora, as well as on the sides of the body; mesosternal process

short and obtuse, very pubescent in front. The front tibiæ are slender, and show only indistinct indications of teeth.

In the male the pygidium and last ventral segment are rather longer than in the female, and the legs are rather longer and more slender.

There was only a single individual of this species in Mr. Belt's collection; but I have a fine specimen in my own collection from Central America. The species is allied to *Cotinis pulverulenta*, Burm.; but that species is not half the size, and is said to have the front tibiæ sharply three-toothed.

Cotinis gracilis, n. sp. Supra opaca, olivacea, subtus sat nitida, cuprea, undique squamulis parvis adspersa; clypeo anterius sat reflexo, medio vix prolongato, vertice obscure longitudinaliter elevato, elevationis apice distincto; tibiis anterioribus gracilibus, muticis; coxis posterioribus angulo externo obtuso. Long. 16 millim.

Clypeus with the front margin distinctly elevated, and with a broad short prominence on the middle, vertex obscurely elevated along the middle, the apex of this obscure elevation, however, is quite distinct and prominent, owing to the depression of the clypeus in front of it. Thorax with scattered coarse punctures, in each of which is placed a round pale scale. Elytra similar in colour to the thorax, each with two obscure longitudinal elevations, and with distant fine punctures, which are almost arranged in rows, and each of which is covered by a pale scale. Pygidium rather closely clothed with whitish subdepressed scales or coarse setæ. Under surface brassy, with but little pubescence, but with numerous coarse pale scales. Anterior tibiæ slender and without teeth.

The specimen described is, no doubt, a male, and was found in Honduras by Mr. Dyson. The species is allied to *C. adspersa*, but is much smaller, and has the carina of the vertex obsolete instead of sharply elevated. It must also be allied to *C. pulverulenta*, Burm.; but, from the description, that species has the front tibiæ sharply three-toothed, and the carina of the vertex more distinct.

Euphoria belti, n. sp. Olivaceo-viridis, nitidissima, supra nuda, tarsis nigris; clypeo anterius angustato, margine anteriore reflexo et emarginato, fronte late subbiimpressa; elytris parce punctatis. Long. 20–23 millim.

Head small, the clypeus distinctly narrowed in front, and the front margin prolonged and reflexed, and emarginate in the middle, so as to be almost bidentate; the upper part of the head is a good deal depressed in the middle and coarsely punctured; and this impression is obscurely divided into two by the middle being slightly elevated. The thorax is very shining, and is short in proportion to the width; it is

only sparingly punctured; the middle part, indeed, is almost free from punctures. Scutellum large, quite impunctate. Elytra only finely and sparingly punctured, the punctures arranged almost in lines, the sides towards the apex and the apex strigose. Pygidium strigose, but shining. Under surface green; sides of the breast with scanty pale hairs and coarsely strigose, the centre smooth and shining. The mesosternal process very short and broad, densely pubescent along its front. Front tibiæ acutely tridendate.

This species is allied to *Cetonia fulgida*, Fab. (genus *Erirhipis*, Burm.), but is larger, without pale marks, and has the head differently shaped.

Though I have examined a series of ten individuals of this species, I see no indications of any external sexual distinctions.

Geographical Distribution of Indian Freshwater Fishes.—Part I. The Acanthopterygii, Spiny-rayed Teleostean Fishes. By Francis Day, F.L.S., F.Z.S., &c.

[Read December 7, 1876.]

During comparatively recent times much interest has been manifested regarding the geographical distribution of the fauna of India, and arguments have been adduced to demonstrate the predominance in it of the Malayan or African element.

As a small contribution to the facts which are being accumulated, I propose a consideration of the distribution of the freshwater fishes, believing they must afford evidence upon which some conclusions may be based. My limits will be Hindustan proper, including the Punjab and Sind, as well as Ceylon, Assam, Burma, the Andamans, and the Nicobars.

The freshwater fishes consist:—

(1) Of those which reside entirely in fresh water.

(2) Of those which enter it from the sea for breeding or predaceous purposes.

The second will be briefly considered, and only when the species belongs to a genus which likewise inhabits fresh water. In such instances it will be necessary to trace out every species of which the genus is composed.

The freshwater fishes, thus circumscribed, consist of:—

(*a*) Hill-residents, whether entirely or occasionally.

(*b*) Fishes of the plains, some of which are migratory, extending their range over vast regions, whilst others are more locally distributed, such as being confined to Cutch, or Western or Southern India including Ceylon, or restricted to the deltas of large rivers.

This investigation may, for convenience, be divided into:—

I. The distribution of Acanthopterygii.
II. " " Anacanthini and Siluridæ.
III. " " Cyprinidæ, Clupeidæ, and their allies.

Restricting myself in this paper to the Acanthopterygian or spiny-rayed Teleostean fishes, we find nine families which possess true freshwater representatives in India. They are as follows:—

1. PERCIDÆ. Genus 1. *Ambassis*[1], Commerson.
   a. Fresh waters throughout India, also in Malay archipelago.
   b. Marine, both Malay archipelago and Africa.

2. NANDIDÆ. Genus 1. *Badis*[2], Bleeker.
   Fresh waters of India (excluding Sind and Ceylon[3]) and Burma.
   Genus 2. *Nandus*[4], Cuv. & Val.
   Fresh waters of India to the Malay archipelago.
   Genus 3. *Pristolepis*[5], Jerdon.
   Malabar[6], Burma, Siam, and Malay archipelago.

[1] This genus includes:—*Chanda*, pt., Ham. Buch.; *Hamiltonia*, Swainson; *Bogoda*, *Parambassis*, and *Pseudambassis*, Bleeker.

[2] Includes *Bedula*, Gray.

[3] The fishes of Ceylon have been so little worked out, that none of this family have been as yet recorded from that island; but such is by no means conclusive evidence that they do not live there. I suspect *Nandus marmoratus* will be found in the waters of the plains, and some species of *Pristolepis* in those of the hills. Whilst writing this paper I discovered in the Indian Museum a collection of Ceylon fishes made by Dr. Kelaart, amongst which are several common to the continent of India.

[4] Includes *Bedula*, Gray.

[5] Includes:—*Catopra*, Bleeker; *Paranandus*, Day.

[6] By *Malabar* I do not understand the districts so designated in Bloch's time; I only mean the western coast of India from below Mangalore. In former days the lower portion of the Coromandel coast was so termed; and even now the natives of Madras designate those residing to the south as Malabars.

3. SCIÆNIDÆ. Genus 1. *Sciæna*[1].
   - *a.* Fresh waters of India and Burma to the Malay archipelago.
   - *b.* Marine species found also in Africa and the Malay archipelago. This family does not appear to be represented in the Red Sea, doubtless due to the water being too clear, and no large rivers opening along its coasts.

4. GOBIIDÆ. Genus 1. *Gobius*[2], Artedi.
   - *a.* Fresh waters of India, Ceylon, Malay archipelago, and Africa.
   - *b.* Marine, in India, Ceylon, Malay archipelago, and Africa.

   Genus 2. *Sicydium*[3], Cuv. & Val.
   - *a.* Fresh waters of Canara[4] and Burma to the Malay archipelago and beyond.

   Genus 3. *Periophthalmus*, Schn.

   Larger rivers of Bengal and Burma to the Malay archipelago and beyond, also West Africa.

[1] Includes:—*Johnius*, Bloch; *Corvina* and *Stellifer*, Cuv.; *Bola*, pt., H. B.; *Leiostomus*, Cuv. & Val.; *Coracinus*, Pall.; *Homoprion*, Holb.; *Amblyodon* (Raf.), Gill; *Cheilotrema*, v. Tsch.; *Genyonemus*, *Plagioscion*, *Sciænops*, *Bairdiella*, *Haploinodotus*, *Rhinoscion*, and *Ophioscion*, Gill; *Diplolepis*, Steind.; *Pseudosciæna*, Bleeker.

[2] For synonyms see 'Fishes of India,' p. 282.

[3] Includes:—*Sicyopterus*, Gill; *Catylopus*, Guich.; *Sicydiops* and *Microsicydium*, Bleeker.

[4] The following species was obtained from the fresh water of Canara, but having been mislaid, was omitted from the 'Fishes of India.' As, however, its existence is of importance in the geographical distribution, I describe it here.

SICYDIUM GRISEUM, n. sp.

B. iv. D. $6/\frac{1}{10}$, P. 17, V. 6, A. 11, C. 13, L. l. 80, L. tr. ca. 25.

Length of head $5\frac{1}{2}$, of caudal fin $6\frac{1}{2}$, height of body 6 in the total length. *Eyes*, diameter 4 in the length of the head, rather above 1 diameter from the end of snout, and $1\frac{1}{2}$ apart. *Body* subcylindrical; upper surface of the head flat, and its greatest breadth equalling its width. Cleft of mouth extending to below the first third of the eye. Lower jaw horizontally placed. Lips thick, the upper with a coarsely fringed edge: snout not overhanging the mouth. No barbels. *Teeth*—in the upper jaw, small, closely set, and implanted in the gums in a single row: in the lower jaw the outer row horizontal; posterior to them, and above the symphysis, are two strong recurved canines. *Fins*—dorsal spines filiform and projecting beyond the membrane; caudal rounded. *Scales* strongly ctenoid, of irregular sizes and shapes, and in irregular rows; they extend forwards to nearly as far as the eyes; none on the head. *Colours*—brownish, with eight or nine rings of a

Genus 4. *Eleotris* [1], Gronovius.
Large rivers of India, Africa, and the Malay archipelago.

5. Rhynchobdellidæ. Genus 1. *Rhynchobdella*, Cuv. & Val.
From Syria through Sind, India, Ceylon, Burma, to the Malay archipelago.
Genus 2. *Mastacembelus*, Cuv. & Val.
From Syria through Sind, India, Ceylon, Burma, to the Malay archipelago; also West Africa.

6. Mugilidæ. Genus 1. *Mugil*, Artedi.
a. Fresh waters of Sind, N.W. provinces, Bengal, Assam, Burma.
b. Marine, to the Malay archipelago and Africa.

7. Ophiocephalidæ. Genus 1. *Ophiocephalus*, Bloch.
Fresh waters of Beluchistan, Afghanistan, throughout India and Ceylon to the Malay archipelago.
Genus 2. *Channa*, Gronov.
Ceylon and China.

8. Labyrinthici. Genus 1. *Anabas*, Cuvier.
India and Ceylon to the Malay archipelago.
Genus 2. *Polyacanthus*, Cuv. & Val.
Canara, Southern India, Ceylon, to the Malay archipelago.
Genus 3. *Osphromenus* [2], Lacép.
Eastern Bengal, Assam, to the Malay archipelago.
Genus 4. *Trichogaster* [3], Bloch.
Sind, through India (except Madras and south of the Kistna, Malabar, and Ceylon) to Burma and Siam.

9. Chromides. Genus 1. *Etroplus*, Cuv. & Val.[4]
Western and Southern India, also Ceylon.

If we examine the foregoing 9 families and 19 genera, we

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darker tint surrounding the body and wider than the ground-colour; fins dark, most deeply so at their edges.
Hab. South Canara, where I procured two specimens in fresh water, the longest being 3 inches.

[1] For genera included see 'Fishes of India,' p. 309.
[2] Includes:—*Trichopus*, Lacép.; *Ctenops*, M'Clell.; *Trichopsis*, Kner.
[3] Includes *Colisa*, Cuv. & Val.
[4] Includes *Pseudetroplus*, Bleeker.

cannot help observing that they do not give one single instance of a freshwater genus being restricted to India and Africa, whilst the majority are common to the Indian and Malayan faunæ. In short, they may be divided as follows:—Of the 19 freshwater genera, 15 reach the Malay archipelago; of the remaining 4 genera, *Badis* exists in Burma, and may extend to Siam and beyond, *Trichogaster* is found in Siam, whilst *Channa* is common to Ceylon and China. The remaining genus, *Etroplus*, is confined to Western and Southern India, also Ceylon; whilst recently Dr. Bleeker has discovered that a nearly allied genus (*Paretroplus*, Bleeker) is present in Madagascar. This island, however, may or may not originally have been joined on to Africa. It has been observed that "Madagascar, divided from Africa by a deep channel 300 miles wide, possesses so many peculiar features as to indicate separation at a very remote antiquity, or even to render it doubtful whether the two countries have ever been absolutely united" (Wallace, 'Malay Archipelago,' ii. p. 11).

Out of the foregoing 19 freshwater genera existing in India, only 3 have as yet been recorded from Africa, but 15 from the Malay archipelago, whilst all the marine genera common to Africa and India extend to the Malay archipelago.

It may therefore be fairly assumed that amongst the freshwater Acanthopterygian fishes of India and Ceylon a well-marked Malayan character is present, whereas an African element is but slightly apparent.

Having thus briefly disposed of the families and genera, it becomes necessary to show where the various species reside, and the range within which they are limited, in order to attempt to evolve whether any, and, if so, what subregions exist.

Fam. PERCIDÆ.

Genus AMBASSIS.

1. A. NANA[1], *Ham. Buch.*

Sind, the entire plains of India (excluding the Malabar coast and Assam), to Burma.

2. A. RANGA[2], *Ham. Buch.*

[1] Includes:—*Chanda phula* and *C. bagoda*, Ham. Buch.; *Ambassis oblonga*, Cuv. & Val.; *A. indica*, M'Clelland.

[2] Includes:—*Chanda lala*, Ham. Buch. (young); *C. ruconius*, M'Clelland; *Ambassis Barlovi*, Sykes; *A. alta*, Cuv. & Val.

Sind, the entire plains of India (excluding the Malabar coast and Assam), to Burma.

3. A. BACULIS, *Ham. Buch.*
From the Punjab to Bengal, Orissa, and Burma.

4. A. THOMASSI, *Day.*
Western coast of India, from South Canara, certainly as low as Cochin.

5. A. DAYI [1], *Bleeker.*
Malabar coast of India, especially its more southern portions.

The representatives of this genus in India are divisible into three classes:—

A. *Marine.*—1. *A. Commersonii*, Cuv. & Val., from the Red Sea and east coast of Africa, throughout the Indian Ocean. 2. *A. interrupta*, Bleeker, from the Andamans to the Malay archipelago. 3. *A. gymnocephalus* [2], Lacép., from the east coast of Africa, through the seas of India, to the Malay archipelago. 4. *A. urotænia* [3], Bleeker, from (? Red Sea,) Seychelles and Andamans to the Malay archipelago.

Out of the foregoing 4 marine species, 3 appear to be common to both the African and Malayan faunæ, and 1 to the Andamans as well as to the Malay archipelago.

B. *Estuary.*—This comprises species concerning which it is very difficult to decide whether they mostly prefer brackish water or extend their range downwards to the sea or upwards into the rivers. Thus we have *A. nalua*, H. B., which appears to frequent the entire coast of India, the Andamans, and the Malay archipelago.

C. *Freshwater.*—There are 5 species at present recognized: 2 are generally distributed throughout Sind, India, and Burma, excluding the Malabar coast; 1 appears to be absent from Sind and Southern India, but is otherwise distributed as the other two species. The remaining 2 species are found from Canara down the western or Malabar coast of India.

The deduction from the foregoing must be that South Canara and Malabar possess distinct species of this genus from those distributed elsewhere throughout Sind, India, and Burma;

[1] Includes ?*A. malabaricus*, Jerdon.

[2] Includes:—*A. Dussumieri*, C. & V.; *Priopsis argyrozona*, C. & V.; *Ambassis Vachelli*, Peters.

[3] Includes ?*A. denticulata*, Klunzinger.

whereas those in the latter wide extent of country appear to be generally diffused. The Malabar[1] are local races, whereas the Hindustan forms are widely spread.

Family NANDIDÆ.

Genus BADIS.

1. B. BUCHANANI, *Bleeker*.

From the N.W. Provinces to Bengal, Orissa, and Western India; also found in Assam and Burma certainly as high as Mandalay.

2. B. DARIO, *Ham. Buch.*

Northern portions of Bengal, Behar, and along the wes tern ghauts of India.

Genus NANDUS.

N. MARMORATUS[2], *Cuv. & Val.*

Throughout the whole of India and Burma (excluding Ceylon and Sind) to Siam.

Genus PRISTOLEPIS.

1. P. MARGINATUS[3], *Jerdon.*

Western ghauts of India and rivers along their bases.

2. P. MALABARICUS, *Günther.*

The same localities as the last, of which it may be merely a variety.

3. P. FASCIATUS[4], *Bleeker.*

Fresh waters of Burma, Siam, and the Malay archipelago.

The species of the three Nandioid genera found in India give the following results:—*Nandus* is generally distributed except in Sind and elevated regions, extending eastward at least to Siam. It is a widely diffused fish. *Badis* shows species (perhaps the two are varieties of one) extending from the plains on to moderately elevated hills, and having a wide distribution to the east. *Pristolepis* is more confined to hilly regions or their bases in India proper, or, rather, Malabar; and then a wide hiatus exists, as it has not been discovered nearer than Burma, where it is found in the plains. There is, however, a slight difference in these fishes, which

[1] I have omitted allusion to *A. thermalis*, C. & V., from the warm springs of Cania, in Ceylon, and which may be one of those mentioned as found in India. Anyhow it proves the existence of this genus in the fresh waters of Ceylon.

[2] Includes *Bedula Hamiltonii*, pt., Gray & Hardw.

[3] Includes *Catopra tetracanthus*, Günther.

[4] Includes *Catopra siamensis*, Günther.

should be remarked. The Malabar form or forms have villiform teeth on the vomer; those in Burma and to the east have globular ones.

Fam. SCIÆNIDÆ.

Genus SCIÆNA.

S. COITOR[1], *Ham. Buch.*

Throughout the larger rivers of India and Burma, descending to the sea at certain seasons. It has been taken in the Malayan peninsula by Dr. Cantor.

Estuary and marine examples of this genus are found both along the coasts of Africa, through the sea of India, to the Malay archipelago and beyond.

The following species inhabit the seas and estuaries of India:—

1. *Sciæna Bleekeri*, Day, Beluchistan to Bombay. 2. *S. miles*[2], Lacép., seas of Africa to the Malay archipelago. 3. *S. Vogleri*, Bleeker, seas of India to the Malay archipelago. 4. *S. sina*, Cuv. & Val., from Beluchistan through the seas of India to the Malay archipelago. 5. *S. cuja*[3], Ham. Buch., estuaries of the Ganges and Japan. 6. *S. axillaris*, Cuv. & Val., seas of India. 7. *S. albida*[4], Cuv. & Val., seas and estuaries of India and Burma. 8. *S. diacanthus*[5], Lacép., seas and estuaries of India to the Malay archipelago and China. 9. *S. aneus*[6], Bloch, seas of India to the Malay archipelago. 10. *S. maculata*[7], Bl. Schn., seas of India. 11. *S. Belengeri*[8], Cuv. & Val., seas of India to the Malay archipelago and beyond. 12. *S. semiluctuosa*, Cuv. & Val., from Be-

[1] *Sciæna (Corvina) nasus*, Steind., from Calcutta, is probably this species; also *Johnius Dussumieri*, Cantor, from Pinang, the Malayan peninsula, and Singapore.

[2] Includes:—*Labrus tella katchelee*, Russell; *Corvina soldado*, Cantor; *C. Wolfii*, *sampitensis*, and *celebica*, Bleeker; *C. dorsalis*, Peters,—from the Mozambique through the seas of India to the Malay archipelago.

[3] *Sciænoides asper*, Blyth (young).

[4] Includes:—*Bola coitor*, Ham. Buch.; *Johnius anei*, Blyth; *Corvina Neilli*, Day.

[5] Includes:—*Labrus nella katchelee*, Russell; *Bola chaptis*, H. B.; *Johnius cataleus* and *Corvina platycephala*, Cuv. & Val.; *Sciæna maculata*, Gray & Hardw.; *Johnius Valenciennei*, Eyd.

[6] Includes *Otolithus macrophthalmus*, Bleeker.

[7] Includes *Perca sari-kullah*, Russ.

[8] Includes:—*Sparus*, Russell, fig. cxi.; ? *Corvina lobata*, Cuv. & Val.; *C. Kuhlii*, Cuv. & Val.

luchistan through the seas of India to China. 13. *S. glaucus*, Day, seas of India. 14. *S. carutta*[1], Cuv. & Val., seas of India to the Malay archipelago. 15. *S. osseus*, Day, Malabar coast of India.

The foregoing 15 species of marine and estuary Sciænas can be divided thus:—6 as yet recorded only from India; 8 India to the Malay archipelago, or China, or Japan; 1 from India and Africa to the Malay archipelago. But the fact must not be overlooked that there has been no worker along the African coast as Bleeker has worked the fish-fauna of the Malay archipelago.

Fam. Gobiidæ.

Genus Gobius.

G. giuris*, *Ham. Buch.*

Fresh water throughout the plains of India, Sind, Ceylon, and Burma to the Malay archipelago and east coast of Africa; also found along the coast.

The following species inhabit the seas and estuaries, some ascending up tidal rivers:—

1. *G. bynoensis*[2], Richardson, sea at Andamans and Malay archipelago. 2. *G. sexfasciatus*, Day, sea, Madras. 3. *G. brevirostris*, Günther, sea at Kurrachee in Sind, also China. 4. *G. griseus*, Day, estuaries, Madras. 5. *G. polynema*, Bleeker, seas of India and Malay archipelago. 6. *G. macrostoma*, Steind., sea, Bombay. 7. *G. viridipunctatus*[3], Cuv. & Val., from Sind through the seas of India to the Malay archipelago. 8. *G. ocellatus*, Day, sea, Sind and Bombay. 9. *G. Masoni*, Day, sea, Bombay. 10. *G. cyanomos*[4], Bleeker, seas of India to the Malay archipelago. 11. *G. criniger*[5], Cuv. & Val., seas of east coast of Africa, India, to the Malay archipelago. 12. *G. puntang*[6], Bleeker, estuaries

[1] Includes *S. carouna*, C. & V.

* Includes:—*G. korah mottah*, *koku*, and *bullee kokah*, Russell; *G. kurpah*, Sykes; *G. kokius*, *catebus*, and *kora*, Cuv. & Val.; *G. platycephalus*, Peters; *G. spectabilis*, Günther.

[2] Includes *G. stethophthalmus*, Bleeker.

[3] Includes:—*G. nuna mottah*, Russell; *G. venenatus*, Cuv. & Val.; *G. chlorostigma*, Bleeker.

[4] Includes *G. setosus*, Jerdon (not Cuv. & Val.).

[5] Includes:—*G. brevifilis*, Cuv. & Val.; *G. Kreffti*, Steind.; *G. caninus*, Günther and Playfair, Fish. Zanz. (not Cuv & Val.).

[6] Includes *G. andamanensis*, Day.

and the sea from the Andamans to the Malay archipelago. 13. *G. Bleekeri*, Day, estuaries, Madras. 14. *G. zonalternans*, Day, brackish water, Madras. 15. *G. biocellatus*[1], Cuv. & Val., coasts of Sind, India to the Malay archipelago. 16. *G. madraspatensis*, Day, estuaries, Madras. 17. *G. Neilli*, Day, sea and estuaries, Madras. 18. *G. melanosticta*, Day, estuaries of Madras. 19. *G. cristatus*, Day, coasts of India. 20. *G. tentacularis*[2], Cuv. & Val., seas of India to the Malay archipelago. 21. *G. acutipennis*[3], Cuv. & Val., seas of India to the Andamans. 22. *G. striatus*, Day, estuaries of Madras and Canara, ascending rivers. 23. *G. personatus*[4], Bleeker, estuaries and seas of India to the Malay archipelago. 24. *G. malabaricus*, Day, estuaries of Madras, and ascending rivers in Malabar. 25. *G. planifrons*, Day, sea, Bombay. 26. *G. elegans*, Cuv. & Val., sea, Bombay and Malay archipelago. 27. *G. ornatus*[5], Rüpp., Red Sea, seas of India, to the Malay archipelago. 28. *G. gutum*, Ham. Buch., estuaries of the Hooghly. 29. *G. albo-punctatus*[6], Cuv. & Val., Red Sea, seas of India, Andamans, to Feejee and beyond. 30. *G. semidoliatus*, Cuv. & Val., Red Sea, Andamans. 31. *G. magniloquus*, Day, sea, Madras. 32. *G. planiceps*, Day, sea, Madras. 33. *G. sadanundio*, Ham. Buch., estuaries of Ganges and sea along the coast of Burma. 34. *G. melanosoma*[7], Bleeker, Andamans and Nicobars to the Malay archipelago. 35. *G. nunus*, Ham. Buch., estuaries of the Hooghly and Burma, ascending rivers.

The foregoing 35 species of marine and estuary Gobies (*Gobius*) can be divided thus:—21 as yet only recorded from India; 11 common to India and the Malay archipelago; 2 common to India and China or beyond; 1 common to Africa, India, and the Malay archipelago.

[1] Includes *G. celebicus*, Cuv. & Val.; *G. sublitus*, Cantor.

[2] Includes *G. macrurus*, Bleeker.

[3] Includes *G. setosus*, Cuv. & Val.

[4] Includes:—*G. melanocephalus* and *grammepomus*, Bleeker; *G. litturatus*, Steind.; *G. Stoliczkæ*, Day.

[5] Includes:—*G. ventralis*, Cuv. & Val.; *G. interstinctus*, Richardson; *G. periophthalmoides*, Bleeker.

[6] *G. punctillatus*, Rüpp.; *G. Padangensis*, Bleeker; *G. breviceps*, Blyth.

[7] Includes *G. gobiodon*, Day.

Genus Sicydium.

1. S. fasciatum, *Day.*
Fresh water of Burma.

2. S. griseum, *Day.*
Fresh water of Canara.

Genus Periophthalmus.

P. Schlosseri[1], *Pallas.*
This little fish is found in fresh water and also in estuaries from Bengal to the Malay archipelago.

The following species likewise inhabits the sea and estuaries:—*P. Koelreuteri*[2], Pallas. It extends from India to the Malay archipelago.

Genus Eleotris.

E. fusca[3], *Bl. Schn.*

This fish is found far inland in fresh water; it also inhabits the west coast of Africa, seas of India to the Malay archipelago and beyond.

The following species of this genus inhabit the seas and estuaries, some ascending tidal rivers:—1. *E. macrolepidota*, Bloch, said to have come from India. 2. *E. muralis*, Cuv. & Val., seas of India to the Malay archipelago. 3. *E. sexguttata*, Cuv. & Val., Ceylon to the Malay archipelago. 4. *E. feliceps*, Blyth, Andamans. 5. *E. macrodon*, Bleeker, estuaries of Lower Bengal and Burma. 6. *E. porocephalus*[4], Cuv. & Val., seas and estuaries of Burma, and the Andamans to the Malay archipelago. 7. *E. ophiocephalus*[5], Cuv. & Val., coasts of Africa, Andamans, to the Malay archipelago. 8. *E. cavifrons*, Blyth; Andamans. 9. *E. canarensis*, Day, Canara. 10. *E. lutea*, Day, Andamans. 11. *E. scintillans*, Blyth, Akyab and Andamans. 12. *E. litoralis*, Day,

[1] Includes:—*G. tredecem-radiatus, septem-radiatus,* and *novem-radiatus,* Ham. Buch.; *Periophthalmus Freycineti,* Cuv. & Val.

[2] Includes:—*Periophthalmus papilio,* Bl. Schn.; *P. argentilineatus,* C. & V.; *P. kalolo,* Less.; *P. modestus,* Cantor; *P. dipus,* Bleeker; *P. fuscatus,* Blyth.

[3] Includes:—*Cobitis pacifica,* Forst.; *Cheilodipterus culius,* Ham. Buch.; *Eleotris nigra,* Quoy & Gaim.; *E. mauritianus,* Bennett; *E. incerta,* Blyth; *E. soaresi,* Playfair.

[4] Includes *Eleotris Cantoris,* Günther.

[5] Includes:—*E. margaritacea,* Cuv. & Val.; *E. viridis,* Bleeker.

Andamans. 13. *E. caperata*[1], Cantor, coasts of India, Andamans, to the Malay archipelago. 14. *E. butis*[2], Ham. Buch., seas and estuaries of India to the Malay archipelago. 15. *E. amboinensis*[3], Bleeker, seas and estuaries of India to the Malay archipelago.

The foregoing 15 species of marine and estuary *Eleotres* can be divided thus:—8 as yet only recorded from Indian localities; 6 common to India and the Malay archipelago; 1 common to India, Africa, and the Malay archipelago.

Fam. RHYNCHOBDELLIDÆ.

Genus RHYNCHOBDELLA.

R. ACULEATA[4], *Bloch.*

Estuaries, brackish waters, and deltas of large rivers throughout the Indian (? Ceylon) district, and extending to Borneo and beyond.

Genus MASTACEMBELUS.

1. M. UNICOLOR, *Cuv. & Val.*

Fresh waters of Burma to Java.

2. M. ZEBRINUS, *Blyth.*

Fresh waters of Burma.

3. M. PANCALUS[5], *Ham. Buch.*

Bombay Presidency (inland), deltas of large rivers (excluding those of the Malabar coast and Madras south of the Kistna), also Assam.

4. M. ARMATUS[6], *Lacép.*

This freshwater fish is found throughout the Indian region referred to, both on the plains and even the hills; it extends to China.

5. M. GUENTHERI[7], *Day.*

Fresh waters along the Malabar coast of India.

The 5 species show the following distribution:—2 throughout

[1] Includes *E. koilomatodon*, Bleeker.

[2] Includes:—*E. humeralis*, Cuv. & Val.; *E. prismatica*, Bleeker.

[3] Includes *E. buccata*, Blyth.

[4] Includes:—*Rhynchobdella orientalis* and *aral*, Bl. Schn.; *R. ocellata*, Cuv. & Val.; *Mastacembelus pentophthalmus*, Gronov.

[5] Includes *Mastacembelus punctatus*, Cuv. & Val.

[6] Includes:—*M. ponticerianus* and *marmoratus*, Cuv. & Val.; *Macrognathus caudatus*, *undulatus*, and *Hamiltonia*, M'Clelland.

[7] Includes ?*Mastacembelus malabaricus*, Jerdon.

India to China; 1 India, excluding the west and south coasts, also Assam; 1 locally in the Malabar coast; 1 locally in Burma.

Family MUGILIDÆ.

Genus MUGIL.

1. M. CORSULA, *Ham. Buch.*
Rivers and estuaries of Bengal and Burma.

2. M. HAMILTONII, *Day.*
Rivers of Burma.

3. M. CASCASIA, *Ham. Buch.*
Ganges and Jumna rivers; also in the Brahmaputra, in Assam.

Of the foregoing three species of Mullets[1] from the fresh waters of India and Burma, none has been recognized either in Africa or the Malay archipelago.

Following out the sea and estuary species of this genus would lead to no conclusions. Mullets extend their range through vast regions; and those found in India and Africa appear, with but few exceptions, to be also present in the Malay archipelago. It is curious, however, that the freshwater species in India have strongly ctenoid scales, such in the marine forms being usually cycloid or feebly ctenoid.

Fam. OPHIOCEPHALIDÆ.

Genus OPHIOCEPHALUS.

1. O. MARULIUS[2], *Ham. Buch.*
Fresh waters throughout India and Ceylon to China.

2. O. LEUCOPUNCTATUS[3], *Sykes.*
Deccan, Coromandel and western coasts of India, China.

3. O. PSEUDOMARULIUS, *Günther.*
? Mysore, probably a hybrid.

4. O. BARCA[4], *Ham. Buch.*
Large rivers of Bengal, N.W. Provinces, and Assam.

[1] Great errors occur in the distribution of Indian fishes, due to mistakes originating with European museum-naturalists, who, transposing labels, still adhere to their original statements. Thus *M. nepalensis*, Günther, is evidently a skin of *M. dussumieri*, Cuv. & Val., erroneously labelled Nepal instead of Calcutta.

[2] Includes ? *Ophiocephalus Theophrasti*, Val., and *O. aurolineatus*, Day (young).

[3] Includes Russell's pl. 173, *O. grandinosus*, C. & V.

[4] Includes ? *O. nigricans*, C. & V., and *O. amphibius*, M'Clelland.

5. O. MICROPELTES[1], *Cuv. & Val.*

Canara and Malabar, also Siam to the Malay archipelago.

This fish is very peculiar in its colour; having obtained one at Cochin of a bright scarlet with two black bands along the body, in 1863, I naturally concluded it could not be the immature of *O. micropeltes*, described in the 'Catalogue of Fishes of the British Museum' as "brown with lighter longitudinal stripes." Returning to that coast ten years subsequently, I discovered the *O. micropeltes* at Trichoor, about 40 miles north of Cochin; and a few months subsequently I was enabled to collect in Canara adult and young. At Berlin, and subsequently at Dr. Bleeker's, I have convinced myself of their identity. But it is very peculiar that this fish has such a local distribution in India, reappearing in Siam.

6. O. STRIATUS[2], *Bloch.*

Fresh waters of the plains in the Indian and Ceylon region, Burma, to the Malay archipelago and beyond.

7. O. STEWARTII, *Playfair.*

Cachar and Assam.

8. O. GACHUA[3], *Ham. Buch.*

Fresh waters of the plains, and also some of the hilly ranges of Beluchistan, Afghanistan, the Indian and Ceylon region, Burma, and the fresh waters of the Andamans.

9. O. PUNCTATUS[4], *Bloch.*

Fresh waters of the plains in the Indian and Ceylon region, Burma.

The 9 foregoing species show the following distribution:—2 throughout India to the Malay archipelago or China; 1 the Indian region, including Ceylon, Burma, and the Andamans; 1 the Indian region, including Ceylon and Burma; 1 Deccan, Western and Coromandel coast and China; 1 perhaps Mysore; 1 large rivers of Bengal, N.W. Provinces, and Assam; 1 Malabar coast, then absent until Siam, whence it extends to the Malay archipelago; 1 Cachar and Assam.

The distribution of the *Ophiocephali* deserves particular attention, one species, identical with *O. gachua* of India, being found in the Andamans. Reasons will be subsequently adduced favour-

[1] Includes *O. serpentinus*, C. & V., and *O. diplogramme*, Day (young).

[2] Includes *O. wrahl*, Lacép., and *O. chena*, Ham. Buch.

[3] Includes:—*O. kora molta*, Russell; *O. aurantiacus*, Ham. Buch.; *O. fuscus*, *marginatus*, and *limbatus*, Cuv. & Val.; *O. montanus*, M'Clelland; *O. Kelaartii*, Günther.

[4] Includes:—*O. karrouvei*, Lacép.; *O. latus*, Ham. Buch.; *O. indicus*, M'Clelland; *O. affinis*, Günther. Fresh waters of the plains of the Indian region and Ceylon.

ing the belief that the freshwater fishes of the Andamans and Nicobars are identical with those of India. But as freshwater fishes cannot live in the sea, they are unable to pass from the mainland to distant islands; consequently there must at some anterior period have been a land connexion to make the continuity of the fresh waters possible. Admit such to be a fact, there arises the question, Are the aborigines to be considered African whilst the freshwater fish are Indian? or are we to look to the remnants of the aboriginal races of the hills of Hindustan to find the relatives of these people? Does not the presence of these Indian fishes at the Andamans afford another link in the evidence that those coral islands are sinking? for were they rising from the ocean, how could we expect to find *Ophiocephalus gachua*, H. B., and *Haplochilus panchax*, H. B., in existence in their fresh waters? Introduced the latter one could not have been; for it to cross the intervening seas is an impossibility,—leaving us to believe either in a former land connexion or a new creation, and that not of new species but of fishes identical with those on the mainland of India. Again the *O. leucopunctatus* appears in the Deccan and around the coasts, reappearing in China. But the *O. micropeltes* is still more extraordinary: it appears to be confined to Canara and Malabar nearly as far south as Cochin; then it is entirely absent until Siam is reached, whence it extends eastwards.

Genus CHANNA.

C. ORIENTALIS[1], *Bl. Schn.*

This species has only been found in Ceylon. It is very similar to *Ophiocephalus gachua*, which is frequently found with one of its ventrals deficient.

Fam. LABYRINTHICI.

Genus ANABAS.

A. SCANDENS[2] *Dald.*

Throughout Bengal, Assam, throughout Southern India, the Malabar coast, and Ceylon; also Burma to the Malay archipelago and beyond.

Genus POLYACANTHUS.

1. P. CUPANUS, *Cuv. & Val.*

Southern India on the Malabar and Coromandel coasts.

[1] Includes *Channa indica*, Gronov. ed. Gray.

[2] Includes:—*Anthias testudineus*, Bloch; *Cojus cobojius*, Ham. Buch.; *Anabas spinosus*, Gray & Hardw.; *A. trifoliatus*, Kaup; *A. oligolepis*, Günther.

2. P. SIGNATUS, *Günther*.
Ceylon and Java.

Genus OSPHROMENUS.

O. NOBILIS, *M'Clelland*.
Rivers of N.E. Bengal and Assam, extending to those of the hills.

Genus TRICHOGASTER.

1. T. CHUNA[1], *Ham. Buch.*
Deltas of the Ganges and its branches, and the Brahmaputra.

2. T. LABIOSUS, *Day*.
Irawaddi.

3. T. FASCIATUS[2], *Bl. Schn.*
Coromandel coast of India as far south as the river Kistna, Sind, Punjab, N.W. Provinces, estuaries of the Ganges, Orissa and Assam, also throughout Burma.

4. T. LALIUS[3], *Ham. Buch.*
Sind, Jumna, and Ganges rivers as low as Calcutta.

Fam. CHROMIDES.

Genus ETROPLUS.

1. E. CANARENSIS[4], *Day*.
Fresh waters of South Canara, not extending down Malabar.

2. E. MACULATUS[5], *Bloch*.
From Canara down the Malabar coast, Madras, and Mysore.

3. E. SURATENSIS[6], *Bloch*.
From Canara down the western coast, extending inland on to the Ghauts; along the Coromandel coast as high as the Kistna; also Ceylon.

It is now necessary to examine the foregoing species as a whole, showing where they are found, and to where they extend, as only by doing so can one ascertain the tendencies shown towards either the African or Malayan fish-fauna.

[1] Includes ? *Trichopodus sota*, Ham. Buch.

[2] Includes *T. colisa*, *bejeus*, and *cotra*, Ham. Buch., and *Colisa ponticeriana*, Cuv. & Val.

[3] Includes *Colisa unicolor*, Cuv. & Val.

[4] D 22 | 8, A $\frac{15\text{–}16}{6}$. L. l. 31, L. tr. 22. Yellowish buff, with about 8 vertical bluish-black bands. See 'Fishes of India,' p. 414, pl. 89. fig. 5.

[5] Includes *Chætodon kakaitsel*, Lacép., and *Etroplus coruchi*, Cuv. & Val.

[6] Includes *Etroplus meleagris*, C. & V.

Indian region* to Africa and the Malay archipelago	2
" to the Malay archipelago	5
" (excluding Malabar and Assam) to Burma	2
" (excluding Malabar, Assam, and Burma)	1
" (excluding Ceylon and Sind) to Burma	1
" Ceylon and Burma	1
" Ceylon, Burma, and Andamans	1
" (excluding Southern India and Malabar coast)	2
N.W. Provinces and regions to the south, Western India, Assam, and Burma	1
Bengal, Burma, and Malay archipelago	1
Burma, Siam, and Malay archipelago	2
Burma	4
Bengal and Burma	1
N.E. Bengal and Assam	1
Cachar and Assam	1
Sind, Jumna, and Ganges	1
Ganges, Jumna, and Assam	3
Deccan, coasts of India, China	1
Western coast of India, Siam, Malay archipelago	1
Western coast of India	5
Canara	2
Southern India and Malabar	3
Ceylon	1
Ceylon and Java	1
Mysore	1

It is remarkable that I am unable to find a single Acanthopterygian freshwater fish restricted to Africa and India: there are two found in both regions; but they also extend to the Malay archipelago.

Although out of the foregoing 45 species only 2 are residents of Africa, we find 9 of them in the Malay archipelago which are also in India proper, and 2 coexistent in Burma and the Malay archipelago. Another species is common to Ceylon and Java. Or they may be thus divided:—

Restricted to the Indian region	33
Indian region to the Malay archipelago	9
Burma to the Malay archipelago	2
Ceylon to the Malay archipelago	1

* This is intended to mean India, Sind, and the Punjab only.

Of the marine and estuary species, I find:—common to India,

Africa, and the Malay Archipelago...	5
Africa only	1
Malay archipelago	30
India only	35

Acanthopterygian forms of freshwater fishes in India are most numerous in maritime districts, next in the deltas of large rivers, whilst they decrease as we proceed far inland. The Himalayas appear to be their boundary; but on some of the lower ranges the ubiquitous *Ophiocephalus gachua* manages to exist. It is remarkable, however, that the family having the widest distribution is that of the amphibious *Ophiocephalidæ*, whilst it also is the one in which true spines are the least developed.

I propose deferring my general remarks until after the completion of my analysis of the remaining orders of the freshwater fishes, which must be done by following out the range of each individual species. By such means only can we fairly consider it proved whether the African or Malayan fish-fauna most predominates in India: it will show us distinctly the relationship of Ceylon to Southern India; and likewise by such the former continuity between India and the Andamans and Nicobars may be proved or disproved.

Description of a new Hornbill from the Island of Panay. By R. Bowdler Sharpe, M.A., F.L.S., F.Z.S., &c., Senior Assistant, Zoological Department, British Museum.

[Read December 21, 1876.]

In my paper on the birds of the Philippine Islands, which the Society is about to publish in the 'Transactions,' I have noticed an apparently new species of Hornbill from the Island of Panay; but as Mr. Elliot is at the present time engaged on a Monograph of this family of birds (*Bucerotidæ*), I have permitted him to figure this interesting species; and as it is possible that the part of his Monograph containing a description of the bird may appear before my own memoir in the 'Linnean Transactions,' I think it but due to Professor Steere, myself, and the Society, herewith to furnish a short description.

Professor Steere has given me the following notes respecting its habits:—" I shot this Hornbill on the highest ridge of the

mountains west of Ilo-Ilo. This is the only place where any of the virgin forest is left; and there alone I saw these birds. They were not very rare; but I could only get a single specimen, as they flew so high in the trees that my gun could scarcely reach them."

Although closely allied to *C. cassidix*, it differs in several particulars, as will be seen by the following description. General colour above and below greenish black; wings uniform with back; tail black for the basal third, fulvous or light chestnut for the remainder, with a tolerably broad greenish band; head and neck all round dark chestnut, inclining to fulvous above the eye and on the ear-coverts; bill red, the casque deeply grooved.

This interesting bird I propose to call *Craniorrhinus waldeni*, after Lord Walden (The Marquis of Tweeddale), who has, by his excellent memoir on the ornithology of the Philippine Islands, rendered the study of these birds an easier task than could possibly have been the case three years ago.

On the Habits of Hornbills, being extract of a letter by Dr. John Anderson, F.L.S., Indian Museum, Calcutta, to Dr. J. Murie.

[Read December 21, 1876.]

Indian Museum, Calcutta,
November 24, 1876.

In the Zoological Gardens here we have two Hornbills of generic distinctness, *Hydrocissa albirostris* and *Aceros subruficollis*, Blyth. The other morning, on visiting the aviary in which these birds are kept, I was astonished to find the *Aceros subruficollis* tossing about and catching with its bill a specimen of the Little Lorikeet, *Loriculus vernalis*, which it ultimately swallowed head foremost. Since then I have had this bird regularly given one Sparrow a day, which it takes with evident *gusto*. The way in which it tosses the bird about, passing it through its bill from side to side, from the head to the feet, seems to me to indicate that it does so to break the bones. It even goes carefully over each leg of the bird to be swallowed; and the dexterity with which it pitches the bird about without letting it fall is truly remarkable. The bird having undergone sufficient tossing and bill-crushing, is then swallowed head foremost.

Hydrocissa albirostris treats Sparrows in the same manner. The day before yesterday [letter being dated Nov. 24, 1876] I found *Aceros subruficollis* discussing a rare Lory. I don't think that the habit is abnormal; for both birds manifest it and try to catch the smaller birds as they fly past. They are also very well cared for; and particular attention is paid to their food.

I am also rather astonished to find that *Hylobates hoolock* [the Gibbon] has a decided partiality for living birds, eating small living birds with avidity in the same way that *Nycticebus tardigradus* [the Slow Loris] does, seizing the bird by the body and always commencing at the head.

But I could dilate to the extent of some pages on the food and habits of Monkeys.

Further Remarks on the Lemming.

By W. Duppa Crotch, Esq., F.L.S.

[Read November 2, 1876.]

(Plate XIII.)

There are three questions in the natural history of the Lemming which still require elucidation, viz.:—1. Whence do they come? 2. Whither do they go? and 3. Why do they migrate at all? With regard to the first of these, no one has yet supplied an answer. They certainly do not exist in my neighbourhood, which is the most elevated region in Scandinavia, during the intervals of migration; and I suspect that the Kjolen range is assigned to them merely because it is a comparatively unknown district. The answer to question No. 2 is certain: they go to the sea; those on the east of the backbone of Norway go to the Gulf of Bothnia, and those on the west to the Atlantic Ocean. The question as to the cause of these migrations remains; and to this, one of three answers has usually been given:—first, an unusual reproduction and consequent deficiency of food in their usual quarters; secondly, the foreknowledge of approaching severe weather, which is a very popular belief in Norway; thirdly, a natural tendency to descend the mountain-slopes both eastwards and westwards from the watershed between Sweden and Norway.

Now with regard to the first theory, I have invariably noticed during three migrations which I have witnessed, that, just as with the Swallows, one or two individuals have preceded the main body,

and that during the autumn, when the Lemmings first reach my neighbourhood, their number is never large; but after a winter spent beneath the snow, they begin to breed with the first days of summer, and thus develop the extraordinary multitude which is, as it well may be, the astonishment and terror of the country. I think, then, that excessive reproduction results from, and does not cause migration.

The second theory is the mere expression of a popular superstition which has been conclusively falsified during the greater migration of 1876–1877 as well as previously, and may, I think, be entirely omitted from our consideration.

The third theory, that these migrations follow the natural declivities of the country, will be best met by a reference to the diagrams (Pl. XIII.). The chart (fig. 1) shows the general main declivities of the Scandinavian peninsula. Fig. 2 is a plan of the district in which I have observed three migrations in ten years; in this the diagonal path of the Lemmings swimming across my lake in Heimdalen is very remarkable, and was confirmed by almost daily observation. Fig. 3 exhibits, in section, the foregoing plan. I also give a statement from the 'Verdens Gang,' No. 125, for Oct. 23, 1875, Christiania, for what it may be worth. "The proper home of the Lemæn is the Norsk High-Fjeld, both the Langfjelde and Kjölen, whence they migrate to the sea, either to the North Sea, the Atlantic Ocean, or the Gulf of Bothnia." Then follows a list of remarkable migrations:—

By	Throndhjem,	west	1580
„	Nordfjord	„	1648
„	Tornea,	east	1697
„	Lulea	„	1737
„	Umea,	„	1747
„	Throndhjem,	west	1757
„	Kongsberg,	south	1770
„	Hernosand,	east	1823
„	Lyksele,	„	1831
„	Bossekop,	west	1833
„	Karrasuanda,	east	1839

Now, assuming these facts to be accurate, which I confess I think, considering the ridiculous and improbable statements which accompany them, to be at least doubtful, there does certainly seem, at first sight, reason in the supposition that these

migrations follow the watershed, since the backbone of mountains in Norway runs nearly north and south. Thus reference to figs. 2 & 3, Pl. XIII., which gives the course of the Lemmings in 1867–68, 1870–71, and 1875–76, clearly shows that the natural slopes were not followed; and, again, reference to fig. 1 likewise shows that the main valleys in Norway run nearly north and south; whilst we find but one so-called southerly migration, that "by Kongsberg in 1770," respecting which I should much like to know more.

At all events, all these migrations end in the sea, and the Lemmings do not retrace their steps. Again, though four or five generations occur in one summer, the richest grass and the quietest quarters do not tempt the wanderers to remain and settle. I know nothing more striking in natural history than to see the holes, the well-marked runs, and the refuse of these restless creatures which so strangely appear and vanish, while their congener, the Field-Vole, remains in quiet possession of the quarters from which he was temporarily ousted. Probably this same Field-Vole is the only quadruped which does not wage successful war on the Lemmings; and the drawing given in the 'Verdens Gang' *l. c.*, only fails from omitting their enemies; in fact, if they were all depicted, there would be no room for the victims.

I think it must be admitted that, whether instinct be inherited reason or not, its primary object is for the benefit of the species. Here, however, this definition seems to fail just when it need not do so. By staying where they are, or by migrating southwards, most of the emigrants might live in such peace as is allotted to a Lemming; by migrating westward, or even eastward, they necessarily are drowned; but if in former ages land existed where the sea now rolls, a motive is found for these marvellous migrations, and collaterally a strong proof that what we call instincts are but the blind and, sometimes, even prejudicial inheritance of previously acquired experience.

The researches of the naturalists of the 'Challenger' Expedition have disclosed the existence of at least three ridges of submerged land in the Atlantic Ocean, extending some thousands of miles north and south of which the highest summits still remain as islands; and although the intervening valleys are of enormous depth, it may yet well be that lateral connecting ridges exist between those already discovered. Of course it is most improbable that the Lemmings ever journeyed so far south; probably

they did not even reach the "sunken land of Buz," to which 30° W. long. and 55° 30′ N. lat. is assigned; but it is very remarkable that the average depth from Norway to Iceland does not exceed 250 fathoms, with the exception of a deep and narrow channel of 682 fathoms at 14° W. This probably represented the old gulf-stream; and if this were so, the Lemmings did wisely to migrate westwards in search of its genial influence. As little by little the ocean encroached on the land, the same advantages would remain, as in fact they do to this day. But, owing to the rash confidence acquired by crossing with impunity so many lakes and fjords, this singular result is arrived at, that none of the travellers return to teach a lesson of caution to the survivors.

The submerged continent of Lemuria is held to explain many knotty points in the distribution of animals; and I think the existence of a Miocene Atlantis will be found to have a strongly elucidative bearing on subjects of even more interest than the migration of the Lemming. It is difficult to ascertain with any certainty the duration of life in these animals, since very few meet with a natural death. It is, however, clear that they survive the winter; and one which I have in captivity, as well as those now in the Zoological Gardens, are at least three months old. But the fact that the young soon leave their common nest and join the general band of migrants shows, I think, that they are actuated by a common impulse which is neither deficiency of food nor a mere gravitating tendency to roll down hill. It is true that many other animals share this tendency to westward migration; but that fact only intensifies the need of a satisfactory explanation, for which, until a better is found, I am constrained to propose the Miocene Atlantis*.

DESCRIPTION OF PLATE XIII.

Fig. 1. Chart of Scandinavia. The two main valleys, Gudbrandsdalen and the valley of the Glommen, run nearly north and south. The course of the Lemmings crosses these at right angles.

Fig. 2. In this plan of Heimdalen, drawn to scale, the course of the Lemmings will be seen to cross the Lake Heimdalsvand and the swift river Leirungen, both of which might be avoided by a slight detour.

Fig. 3. A section of the same, showing the Lemmings' track, which does not follow the watershed.

The river Leirungen is of glacier origin, very cold and very rapid. Dogs do not like to face it; and yet the Lemmings cross it in thousands.

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* [*Vide* Note "On the occurrence of the Lemming in Newfoundland," Zoologist, Feb. 1877, p. 47.—Ed.]

Observations on the Respiratory Action of the Carnivorous Water-Beetles (Dytiscidæ). By D. Sharp, Esq., M.B. (Communicated by H. W. Bates, Esq., F.L.S. &c.)

[Read November 2, 1876.]

The observations here recorded were commenced by me some time ago, to see if I could get any insight into the peculiarities of the aeration or respiration of the carnivorous Water-beetles, or Dytiscidæ, at a time when I was hoping I should be able to make some inquiries about the function of respiration in the Insecta generally. I very soon found, however, that the subject was so vast, and the difficulties of making accurate minute investigations as to one of the functions of creatures so small as the insects I could procure were so great, that I abandoned my intention. But as the observations I made, though of a desultory character, are not without suggestiveness on certain points, I have thought it worth while they should be placed on record. I think that if such observations were carried out very much more fully and systematically, they would serve as material to enable us to fill up some of the vast gaps which exist in our knowledge of the physiology of this highly organized class of the Invertebrata.

The two most interesting species of all those I observed are undoubtedly *Pelobius Hermanni* and *Hydrovatus clypealis**. These species are, in their structure, much less highly developed for moving through the water than our other indigenous Water-beetles, and are, in my opinion, to be considered (together with the North-American Amphizoa) the most rudimentary or primitive of the existing forms of Dytiscidæ. Their habits quite accord with their structural peculiarities. *Pelobius Hermanni*, though it is a powerful swimmer, moves its limbs in such a rapid manner that it must be incapable of any long-sustained efforts—and, in point of fact, passes its life, in the perfect state, concealed in soft mud, from which it suddenly rises to the surface to take air, and descends again to its concealment with great rapidity. According to my observations, the time it is concealed bears to the time it is exposed for breathing a ratio of 375 to 1; whereas in one of

* I have much pleasure here in acknowledging the kindness of Henry Moncreaff, Esq., who procured and forwarded to me living individuals of these two species, neither of which occurs in Scotland.

the highly developed forms of the family, *Dytiscus marginalis*, the corresponding ratio is about 12 to 1. The amount of food the *Pelobius* takes is surprisingly small; and I have kept the specimens for weeks without giving them any food, and without, I believe, their obtaining any in the water in which they were placed; but they did not appear to suffer from the deprivation. These habits afford a striking example of the truth of Herbert Spencer's generalization, that the grade of development of an organism bears a direct proportion to its activity.

Hydrovatus clypealis is a species that moves extremely little and slowly; and its motion is rather that of running or gliding than of swimming. It glides over the surface at the bottom of the water, and climbs up weeds for the purpose of breathing—and was observed on one occasion, instead of ascending to the surface, to make use of a bubble of gas adhering to a plant; the gas, I suppose, would probably be pure oxygen.

Hyphydrus ovatus is one of the most specialized forms of the Dytiscidæ, but of a form which is of a low type compared with others of the family; and its habits appear to correspond with its structural peculiarities.

The species of *Hydroporus* were only very insufficiently observed; but it would appear from such observations as were made that great diversity will probably be found to exist in the habits of the extremely numerous species of this genus, and that such observations may assist in the difficult task of classifying in a natural manner the species of this extensive genus.

The observations on *Dytiscus marginalis* suggest that the male of this species is more active and breathes more frequently than the female—a fact which quite agrees with the structural peculiarities of the species; for the male is rather larger than the female, and has the swimming-legs very much more developed. This difference between the activity of the sexes is probably general throughout the family. I think it possible that further observations with reference to this fact might throw some light on what has been hitherto an insoluble puzzle to entomologists, viz. the existence in several species of *Dytiscus* of two forms of the female, one of these two forms resembling the male in some of its peculiarities. The genus *Dytiscus* is remarkable in the family, from the great development of the posterior breathing-orifices; but I have failed as yet to obtain any clue to the relation of this structural peculiarity with the habits of the species.

The observations on the two species of *Acilius* appear to show a great difference in habits between the two closely allied species observed; but I think that further and more extensive observations would probably greatly reduce this discrepancy; for I believe that the time of day, the season of the year, the condition of sexual activity, the sex of the individual, the process of digestion, and the condition of hunger, all modify the activity of the Dytiscidæ.

It appears probable that most of the species are much more active by night than by day.

I regret very much that I have not been able to make any observations on *Cybister Roeselii*; for I consider the genus *Cybister* to be, all points considered, the most highly developed form of the family. It is known that some of the species of *Cybister* are enormous devourers of animal food; and I think it probable that observations would show these to be the most active by far of all the members of the family. No species of the genus occurs in Britain; so that it is not likely I shall be able myself to make observations on any of the species.

I have reduced most of the observations made, by a system of averages, so as to allow of their being easily compared with one another, and have given the averages obtained of most of the species.

I. Pelobius Hermanni.

No. 1. Breathing-observation made on four individuals, two ♂, two ♀, August 29th, 1875.—These specimens were completely concealed in soft mud; this they left for breathing, rose rapidly to the surface, and, after breathing, descended with great rapidity and buried themselves in the mud.

Observation commenced at 11.46 A.M.:—

11.57,	only very short time up.		12.36	remained up	3 secs.
12.9	remained up	2 secs.	12.38½	"	13 "
12.10½	"	4 "	12.42	"	5 "
12.17½	"	3 "	12.50	"	3 "
12.26	"	1 sec.	12.51	"	3 "

Observation ceased at 1 P.M. Thus each individual spent only 10 seconds out of 74 minutes at the surface in breathing.

No. 2. Aug. 29th, 1875.—The same four specimens were under surveillance, commencing at 3.40 P.M. and ceasing at 4.30 P.M.:—

3.44, remaining up 3 secs.	4.11, remaining up 10 secs.
3.56 ,, 4 ,,	4.16 ,, 6 ,,
4.10 ,, 2 ,,	4.21 ,, 12 ,,

Thus each individual passed 9 seconds out of 50 minutes in air-exposure.

No. 3. September 5th, 1875.—Observations on four beetles, two males and two females. Watching commenced at 3.22 P.M. when the following ascents were noticed:—

3.23, remained up 3 secs.	4.12, remained up 4 secs.
3.28 ,, 2 ,,	4.36 ,, 3 ,,
3.37 ,, 4 ,,	4.47 ,, 5 ,,
3.38 ,, 2 ,,	4.56 ,, 4 ,,
3.51 ,, 5 ,,	4.58 ,, 20 ,,
3.53 ,, 14 ,,	5.2, observation ceased.

The beetles were entirely concealed under the mud, which they suddenly left and directly returned to.

No. 4. Same date and specimens as in preceding No. 3.—Began to notice their movements at 7.42 P.M., by lamplight, daylight having then gone:—

7.48, remained up 2 secs.	8.22, remained up 2 secs.
7.48 ,, 4 ,,	8.24 ,, 5 ,,
7.50 ,, 5 ,,	8.27 ,, 15 ,,
7.58 ,, 4 ,,	8.29 ,, 6 ,,
8. 2 ,, 3 ,,	8.30 ,, 4 ,,
8. 5 ,, 12 ,,	8.41 ,, 4 ,,
8. 9 ,, 2 ,,	8.42, observation ceased.

That which came up at 7.50 swam round the vase. At 8.7, a specimen left the mud and swam round the vase, but did not rise to the surface. That which arose at 8.22 and remained up 2 seconds made an excursion. These beetles generally kept themselves concealed in the mud, but were not quite so inactive as in the preceding set of observations.

No. 5. Sept. 19.—Kept watch on a female from 3.36 P.M. until 4.36 P.M. It remained buried in the mud all the while, never being seen.

No. 6. Sept. 20th.—Same female as in last, and in the same vase. By lamplight, 8.42 P.M., proceeded to keep a close look-out. The beetle rose at 9.1, and disappeared almost instanta-

neously. At 9.14 and again at 9.28 it acted in a similar way, while at 9.42 I myself stopped short observing. The whole operation of rising, opening elytra at surface, diving and burying itself again in the mud was performed in each case with such rapidity as to yield merely sufficient time for its recognition.

No. 7. Oct. 17th.—This observation, on a female, commenced at 2.1 P.M. It then lay concealed in the mud, but rose at 2.18, resting for about 2 seconds for the purpose of aeration. My observation ceased at 3.4 P.M.

No. 8. Renewed observation at 4.25 P.M., and kept watch until 5.25. During this hour the beetle remained concealed in the mud and was not visible.

No. 9. Same night at 9.7, by lamplight.—The insect was concealed in the mud and did not rise whilst notice was kept, viz. until 10.7 P.M.

The following tabular statement gives the numerical results of the foregoing series of observations.

Observations.	Number of specimens.	Minutes of observation.	Minutes × specimens. =	Ascents.	Seconds at surface.
No. 1...	4	63	252	10	37
„ 2...	4	50	200	6	37
„ 3...	4	100	400	11	66
„ 4...	4	60	240	13	78
„ 5...	1	60	60		
„ 6...	1	60	60	3	3
„ 7..	1	63	63	1	2
„ 8...	1	60	60		
„ 9...	1	60	60		
Totals. .	21	576	1395	44	223

Summary.—From what has been stated, it may be inferred that *Pelobius Hermanni* rises for the purpose of aeration on the average once in every 21¾ minutes, but often goes one hour without ascending to the air. In these observations the time it remained at the surface to perform aeration or respiration varied from a single second, or less, to 20 seconds, and was, on the average, 5 seconds; and the time it was exposed bore to the time it was concealed a ratio of 1 : 375. The observations also suggest

that probably the female is even more sedentary than the male and also that perhaps it is more active after dark than during daylight.

The creature's natural habit appears to be almost constant concealment in the soft mud at the bottom of the water; from this it rises to breathe and descends into the mud with great rapidity.

II. Hydrovatus clypealis.

No. 1. Aug. 29th, 1875.—This observation commenced at 3.15 P.M. The individual, a female, at first was not to be seen, but at about 4.45 was noticed to be walking on the sand at the bottom of the water; and at 4.50 it ascended towards the surface by crawling up the stem of a plant; but before reaching the surface it found a bubble of gas adhering to the plant, when it turned round and backed its posterior extremity into the bubble. The observation ceased at 4.55, when it was still in this position. If this observation be correct, the insect was $1\frac{1}{2}$ hour without breathing; but it is possible that it may have breathed other gas-bubbles on the plant without being noticed. I do not think, however, such was the case.

No. 2. Sept. 12th.—From 4.5 P.M. till 5.45 P.M. (namely, in all, 100 minutes) kept watch on a female specimen of *H. clypealis*, which was concealed under a small stone, and did not emerge during this interval of time.

No. 3. Same date.—At 9.19 P.M., by lamplight, began watching the above-mentioned ♀. At 9.24 it was gliding about the sand, and rose for a scarcely appreciable instant, did not breathe, afterwards glided about, and rose at 9.27 for about 3 seconds to take in air; also at 9.51 for about 3 seconds. The observation ceased at 10.9.

It is possible that the artificial light interfered with its movements; it was observed to pass over the surface of the sand with a comparatively slow motion which appeared to be running rather than swimming, and availed itself of the side of the glass or some object rising to the surface to guide it up; it followed up the course of such object with the running motion above alluded to.

No. 4. Sept. 26th.—No sight of the beetle, which lay concealed under a small stone. Observation from 1.31 P.M. for an hour.

No. 5. Same date.—Observation commenced at 9.11 P.M, by lamplight. At 9.50 it came out from under a stone, crawled up the

plants to the surface, breathed for 15 seconds, then descended and remained quiet on the sand, but not concealed. At 9.56 again rose and breathed for 2 secs., then descended and concealed itself, rose again at 10.7 and breathed for 5 secs., after which it gently moved about. The observation ceased at 10.11 P.M.

The data resultant from these 5 observations are as subjoined:—

Obs.	No. of spec.	Minutes of ob.	Ascents	Aerial exposure.
1	1	100	1	10 min.
2	1	100	–	—
3	1	50	3	6 secs.
4	1	60	–	—
5	1	60	3	22 secs.

Summary.—A female of *Hydrovatus clypealis*, as the result of five observations extending over a period of 370 minutes, was only observed to breathe seven times, or an average of about once in 53 minutes; it has been observed to be 100 minutes without breathing, while, on the other hand, it has been observed that there is sometimes only an interval of 6 minutes between two respirations; the period it remained breathing at the surface varies from 1 sec. or less to 15 secs.

It is probable that the species is more active at night than during the day.

This species appears sometimes to take advantage of a bubble of gas attached to a plant for its breathing, and has been observed remaining for 10 minutes in a position enabling it to breathe such a bubble. It walks or glides rapidly over the surface at the bottom of the water rather than swims, and likes to rise by guiding itself up the stem of a plant; when it swims freely through the water it is only for a short distance.

III. Hyphydrus ovatus.

No. 1. Aug. 29th, 1875.—The female example I here watched was quite quiescent at edge of stone with bubble of gas adhering to its extremity; observation commenced at 3.15 P.M. At 3.52 it moved and came up, but almost instantly descended and renewed its quiescent position; it again ascended at 4.35, and remained up 6 seconds. Observation ceased at 4.53. Thus only about 6 seconds out of 98 minutes were passed in breathing at the surface; the bubble of gas was always present.

No. 2. Sept. 12th.—At 4.5 P.M. took my station at the side of the vase containing the female *H. ovatus*. It appeared at the surface at

4.12, resting there 15 seconds.	4.45, resting there 3 seconds.
4.21 „ „ 25 „	5.17 „ „ 10 „

Observation ceased at 5.45 P.M. The insect carries a bubble at tip of body, which, by movements of the segments, is sometimes retracted under elytra and again exserted without being detached.

No. 3. Commenced observation same night at 9.19 by artificial light. The beetle rose at

9.31, remained up 1 sec.	9.51, remained up 3 seconds.
3.38 „ „ 20 „	9.57 „ „ 20 „
9.44 „ „ 15 „	9.58 „ „ —— †
9.45 „ „ 12 „	10. 3 „ „ 10 seconds.
* 9.45 „ „ 8 „	10. 9, observation ceased.
9.45 „ „ 5 „	
9.45 „ „ 12 „	

No. 4. Sept. 26th.—I watched for one hour from 1.31 P.M., but the female in question did not issue from her hiding-place.

No. 5.—9 P.M. by lamplight. Beetle concealed, and did not emerge till 10.2. It then rose to the surface for the purpose of aeration for 3 seconds, and rapidly repeated the process, thus:—

10.2, at surface 3 seconds.	10. 7, at surface an instant.
10.3 „ 5 „	10. 8 „ „
10.3 „ 4 „	10. 9 „ „
10.3 „ 5 „	10. 9 „ 10 seconds.
10.5 „ 3 „	10.11, observation ended.

It is probable that its aeratory process was considerably interrupted by the disturbance of the artificial light; and hence the above rapid ascents and descents.

* Within the time mentioned in the bracket the *Hyphydrus* descended for an instant—that is, darted down and up again.

† When it rose to the surface at the hour specified, it remained there motionless for a minute or more, but did not then seem to perform aeration. I presume that the insect was incommoded by the artificial light.

Obs.	Spec.	Minutes of observ.	Ascents.	Seconds at surface.
1.	1	98	2	6
2.	1	100	4	53
3.	1	50	11	106
4.	1	60	—	—
5.	1	60	9	33
Totals...	5	368	26	198

Summary.—*Hyphydrus ovatus*, female, conceals itself beneath stone or weed; it rises to breathe on the average once in $14\frac{1}{6}$ minutes, but has been observed to be one hour without breathing; the time it remains at surface varies from an instant to 25 seconds, and is to the time it is concealed in the ratio of 1 : 111·5.

This species is probably more active at night than during the day. It is a rapid and energetic swimmer.

IV. Hydroporus inæqualis.

No. 1. Oct. 10th, 1875.—Observation commenced at 3.41 P.M., the beetle concealed. It, however, rose at 4.10, and remained under atmospheric influence for 5 seconds. Again, 4.39, for 2 seconds; the observation closed at 4.41 P.M.

No. 2. Same evening, 9.14 P.M., by lamplight, *H. inæqualis* being then hidden; but it rose to the surface at 9.27, remaining 5 seconds, and again at 10.8 for the interval of 5 seconds. At 10.14 left off watching.

Obs.	Spec.	Minutes of observ.	Ascents.	Seconds at surface.
1.	1	60	2	10
2.	1	60	2	10
Totals	2	120	4	20

Summary.—Only two observations made, from which it appears that this insect rises once in 30 minutes, and remains at surface about 5 seconds, and the time it is exposed bears to the time it is concealed a ratio of 1 : 360.

V. Hydroporus pictus.

No. 1. August 29th, 1875.—Obs. commenced 3.15 P.M. The beetle was then quiescent under the edge of a stone; at 3.46 came up to breathe, but rapidly descended and became quiescent.

Again ascended at 4.43, but only remained for about 2 seconds. Observation ceased at 4.53.

No. 2. Sept. 12.—Began to watch at 4.5 P.M. At 4.8 the *H. pictus* rose to the surface for an instant only, but did not not do so again, although close attention was given until 5.45 P.M.

No. 3. The same night.—At 9.19 P.M., waited for ten minutes before an ascent was witnessed. The journeys for air succeeded as follows:—

Rose at 9. 2 for 1 second.		Rose at 9.54 for an instant.	
„ 9.37 „ 2 seconds.		„ 10. 4 for 1 second.	
„ 9.45 „ 1 second.		10. 9, obs. ceased.	

These observations were made by lamplight. It is possible the insect was incommoded by the light; it was less quiescent than in the afternoon, making short excursions about the water when it came for breath to surface.

Movements much quicker than those of *Hydrovatus*.

No. 4. Sept. 26th.—When first attention was drawn, viz. at 1.31 P.M., the beetle was under cover. It rose, however, to perform aeration at 2.3 P.M. for 1 second, then it descended and lay concealed as long as the observation lasted, up to 2.31 P.M.

No. 5. Same night.—At 9.11 proceeded to watch by lamplight. At 9.24 this *H. pictus* ascended for an instant, again at 9.44, and again at 10.1, also for an instant. I stopped observing at 10.11 P.M.

Obs.	Spec.	Minutes of obs.	Ascents.	Seconds at surface.
1.	1	98	2	3
2.	1	100	1	1
3.	1	50	5	6
4.	1	60	1	1
5.	1	60	3	3
Totals	5	368	12	14

Summary.—It appears that this very small species rises once in $30\frac{2}{3}$ minutes, and remains at surface about 3 seconds; and the time it is exposed bears to the time it is concealed a ratio of 1 : 1577. It would seem that it takes in its breath very rapidly; for it was never observed to remain at the surface more than 2 seconds.

VI. Hydroporus Gyllenhalli.

No. 1. October 10th.—Beetle of doubtful sex, concealed when observation commenced, 3.41 P.M. But it rose at 3.59 for 1 second

for aeration; again at 4.34, remaining up for 3 seconds. Ceased watching at 4.41 P.M.

No. 2. By lamplight, same night at 9.14, when the beetle was under cover. It afterwards made the following ascents:—

9.38, up for 32 seconds.		9.55, up for 2 seconds.	
9.39 „	2 „	9.55 „	6 „
9.41 „	3 „	9.57 „	2 „
9.44 „	3 „	9.57 „	8 „
9.52 „	2 „	then concealed; obs. ceased	
9.53 „	10 „	at 10.14 P.M.	

It hid itself between 9.44 and 9.52, but during the other intervals continued active.

Obs.	Spec.	Minutes of obs.	Ascents.	Seconds at surface.
No. 1.	1	60	2	4
„ 2.	1	60	10	70
Totals...	2	120	12	74

Summary.—This species was only observed twice; and it appears to be much more active at night than during the day; it rose on the average once in 12 minutes, remaining at surface from 1 to 32 seconds, on an average rather more than 6 seconds on each occasion; and the time it was exposed bears to the time it was concealed a ratio of about 1 : 97¼.

VII. Hydroporus elegans.

No. 1. Oct. 12th.—Kept observation on a male of this species for one hour's duration, viz. between 3.41 P.M. and 4.41 P.M. The beetle was active, and on three occasions during its rapid movements came to the surface of the water, but did not appear to rest there or to take a fresh supply of air.

No. 2. The same night by lamplight.—9.14 P.M. began watch. *H. elegans* was also then active, and rose for the purpose of aeration at 9.49, only remaining up, however, for an instant; again at 9.55 it came to the surface for an instant: 10.14, observation ceased.

Summary.—Only two observations were made on this species, from which it would appear that the species is a very active one, but breathes seldom and very rapidly.

VIII. Hydroporus 12-pustulatus.

No. 1. Sept. 12th, 1875.—Observation commenced at 4.5 P.M. The beetle rose at 4.58 P.M. for a short time; it was otherwise

concealed under a stone and quiescent. This observation ceased at 5.45 P.M.

No. 2. Same date.—Observation commenced at 9.19 P.M. by artificial light. At 9.31, was swimming about with great activity, but apparently did not rise for breath; and the same things occurred at 9.40 and at 9.44, but apparently no breathing. Observation ceased at 10 P.M. I am sure the movements were deranged by the light: the specimen was placed in the dark afterwards, and on being visited was seen swimming about, but speedily took refuge; these results were again repeated on a second visit.

This insect is a powerful swimmer; when placed on its back it uses the front legs with a pawing motion, and strikes out with the hind ones, the latter being generally used simultaneously, but occasionally one after the other. It runs on a dry surface rapidly, trailing the hind legs.

No. 3. Sept. 26th.—The same male beetle, concealed; observation continued for one hour, during which the beetle was quite quiescent and never appeared.

No. 4. At night, by lamplight.—At 9.11 P.M. watch begun, when the beetle came out from concealment at the subjoined times, but did not rise.

9.24	9.40	9.50	10. 4
9.35	9.45	9.53	10.10

Further observation ceased at 10.11 P.M. Thus the beetle did not rise to breathe, though it kept coming out from concealment as if to do so; its movements were perhaps disturbed by artificial light.

Summary.—This species is closely allied to *H. elegans*; and it would appear that, like it, it is often very active and breathes very seldom, and very rapidly.

IX. Noterus sparsus.

No. 1. Sept. 26th.—In this case my observation commenced at 1.31 P.M., beetle concealed at edge of a piece of wood; at 2.23 it crawled up this wood to the surface, breathed for 8 seconds, and returned to its original position. Observation ceased at 2.31 P.M.

No. 2. Resumed watching the same night, with the appended results:—

Rose at :—

9.12 to breathe for an instant.	9.39 to breathe for 17 seconds.
9.14 „ „ 15 seconds.	9.44 „ „ 7 „
9.17 „ „ an instant.	9.47 „ „ 8 „
9.20 „ „ 15 seconds.	9.50 „ „ 15 „
9.25 „ „ 20 „	9.53 „ „ 4 „
9.26 „ „ 8 „	9.57 „ „ 12 „
9.30 „ „ 12 „	9.58 „ „ 12 „
9.30 „ „ 5 „	10. 4 „ „ 5 „
9.35 „ „ 22 „	10.10 „ „ 15 „

Observation ceased at 10.11 P.M.

During this hour the insect was in constant activity, and glided about in the water in a graceful manner, generally rather slowly, and with a motion similar to that of *Hydrovatus*, the four front legs being used in paddling, probably in combination with the hind tarsi or the hind tibiæ and tarsi, the femora being probably flexed and quiet; it can, on being alarmed, shoot away with great velocity, this probably being accomplished by the use of the hind leg in its entirety.

No. 3. Oct. 17th, 1875.—Observations commenced at 2.1 P.M., beetle not having been fed for two days; beetle buried in mud; rose at 2.13 for 5 seconds to breathe, and again at 2.55 for 5 seconds. Observation ceased at 3.4 P.M., beetle fed at 3.6.

No. 4. Observation resumed at 4.25; beetle rose at

4.27 for 2 seconds to breathe.	4.57 for 3 seconds to breathe.
4.31 „ 10 „ „	5.21 „ 1 second to breathe.
Eating.	5.24 „ 5 (?) secs. to breathe.
4.36 for 10 „ „	5.24 „ 1 second to breathe.

Observation ceased at 5.25.

No. 5. Later on observation recommenced at 9.7 P.M., by lamplight; beetle appeared at 9.44 for 4 seconds to breathe. Observation ceased at 10.7.

Obs.	Minutes.	Ascents.	Seconds at surface.
No. 1	60	1	8
„ 2	60	18	184
„ 3	63	2	10
„ 4	60	7	32
„ 5	60	1	4
Totals ...	303	29	238

Summary.—This species rose to breathe on the average once in $10\frac{1}{2}$ minutes, and remained on an average about $8\frac{1}{5}$ seconds for each respiration, this period varying, however, from 1 second to 22 seconds; the time it was exposed for this purpose bearing to the time it was concealed a ratio of about $1:76\frac{1}{3}$. From one observation it would seem that the species is more active by night, but a second observation contradicted this; on this second occasion the beetle had, however, fed largely a few hours before, and this might possibly account for the discrepancy.

X. Laccophilus obscurus, *Schaum.*

No. 1. Sept. 19th, 1875.—A female example of this beetle was quiescent at 3.36 P.M. near the surface in a tuft of weed, reaching to the surface; at 3.39 it quietly ascended the weed to the surface, and, making a very small crack, remained breathing 80 seconds, then quietly descended to its original position; as it descended, a bubble of air was extended, but not detached, till about 3.48, when it was detached, and the beetle rose to the surface as before, and remained breathing just as before for 60 seconds. The above-mentioned descent then reoccurred; at 4.8 the bubble was detached, and at 4.9 the beetle breathed for 55 seconds, and at 4.33 again for 45 seconds. Except for the slight rises and descents, quite quiescent all the time. Observation ceased at 4.36 P.M.

No. 2. Sept. 20th.—The same specimen examined by artificial light at 8.42 P.M., when the following ascents and other movements were taken cognisance of:—

Rose at:—

8.48	for breathing for	2 secs.	9. 8	for breathing for	2 secs.
8.48	„ „	2 „	9. 9	„ „	2 „
8.48	„ „	15 „	9.13	„ „	30 „
8.51	„ „	2 „	9.19	„ „	102 „
8.59	„ „	an instant.	9.23	„ „	5 „
9. 0	„ „	25 secs.	9.28	„ „	20 „
9. 5	„ „	75 „	9.31	„ „	210 „

Observation ceased at 9.42 P.M. The beetle moved about pretty freely in water in a very graceful and perfect manner, having two or three very different motions. In one it undulates slowly through the water (somewhat after the manner of *Hydrovatus*), this being done by paddling with the middle and front legs, while the hind ones are flexed and motionless; a second

faster motion is performed by moving the hind tarsi rapidly (or perhaps the hind tarsi and tibiæ), while the femora are kept flexed on the breast. This motion may be at once changed into a rapid violent shoot forwards, caused no doubt by the femora and the whole of the hind leg being brought into use. When placed on its back out of water it strikes out violently with both hind legs simultaneously; the hopping motion is performed in this way: when walking out of the water, it moves the hind legs alternately.

Obs.	Minutes of observation.	Ascents.	Seconds at surface.
No. 1.	60	4	240
„ 2.	60	14	492
Totals	120	18	732

Summary.—The beetle rose on the average once in $6\frac{2}{3}$ minutes for breathing, and remained on an average $40\frac{2}{3}$ seconds at surface for each respiration. The longest interval observed between two respirations was 20 minutes, and the duration of a respiration varied from 1 second to 210 seconds. The time it was exposed for breathing bore to the time it was concealed a ratio of $1:9\frac{5}{6}$. Only two observations were made, one by night; and it is probable that the species is more active by night.

XI. Colymbetes exoletus.

No. 1. Oct. 17th.—Observation commenced at 2.1 P.M. The insect rose at

2.20 for 40 seconds to breathe.	2.42 for 35 seconds to breathe.
2.29 „ 65 „ „	2.49 „ 55 „ „

At 2.51 it came out of the water and was put back at 2.56; it rose at 2.59 to surface and stayed there 4 minutes. Observation ceased at 3.4.

No. 2. Same afternoon 4.25 P.M.—This ♀ of *C. exoletus* rose for purposes of aeration as follows:—

4.39 for 40 seconds to breathe.	5.11 for 30 seconds to breathe.
4.51 „ 8 „ „	5.20 „ 50 „ „
5. 3 „ 20 „ „	5.25 observation ceased.

No. 3. From 9.7 P.M., by lamplight, the accompanying record of its movements was kept.

Rose at:—

9.18 and remained up 15 seconds.				9.56 and remained up 20 secs.		
9.35	„	„ 75 „		9.57	„	„ 10 ? „
9.40	„	„ 25 „		9.59	„	„ 5 „
9.43	„	„ 2 mins.		10. 0 at surface.		
(breathing doubtful.)				10. 2	„	3 seconds.
9.47 and remained up 15 seconds.				10. 4 at surface.		
9.52	„	„ 3 „		10. 5 at surface.		
9.55	„	„ 30 „		10. 7 observation ceased.		

This individual appeared all day to be uncomfortable: it was restless and active, and kept straining the apical segments of its hind body, and discharging bubbles of gas. It was probably desirous of ovipositing; and I have therefore not compared its activity with that of the other species.

XII. Ilybius fuliginosus.

No. 1. Aug. 22nd, 1875.—Began observing at noon; up at 12.1½.

Again at 12.2½; then was eating piece of a worm at 12.4.

12.6 remained up 30 seconds.

12.8 came up to surface with a piece of a worm, and remained at the surface eating for about 2 minutes.

12.12 remained up for 25 seconds, eating after descent.

*12.14½, remained up for 18 secs.			12.36 remained up for 38 secs.		
*12.15½	„	„ 25 „	12.37	„	„ 10 „
12.19	„	„ 25 „	12.39	„	„ 20 „
12.22½	„	„ 23 „	12.42	„	„ 33 „
12.25	„	„ 19 „	12.46	„	„ 35 „
12.28½	„	„ 25 „	12.50	„	„ 30 „
*12 32½	„	„ 25 „			

At 12.50½ it brought up a piece of a worm to the surface, there remaining, eating it and breathing for 7½ minutes. The *Ilybius* again rose at 12.60 and stayed up for 20 seconds. I left off watching at 1.1 P.M. On descending after the hours marked with an asterisk (*), the insect began eating its food. It was observed that after eating, the specimen only reached the surface with difficulty to breathe, it being probable that the space containing air was diminished by the distended alimentary canal, the quantity of worm eaten being large; bubbles of gas were frequently

emitted by the specimen when under water. The same afternoon this specimen, at 3.19, was observed to be suspended at the surface of the water in an absolutely motionless condition, in which condition it continued till 3.59. Owing to its position, it was not for certain ascertained whether any crack for breathing remained open or not. At 3.59 it moved, and the aperture under the elytra was widely opened; and at 3.60 it descended, but speedily came up again and resumed its former motionless position at the surface, which it retained for nearly half an hour; during this half-hour its position was such that it could be observed with a magnifying lens; this was done several times, and a small breathing-aperture was always observed to be present.

Only a single observation was made on this species, and during that observation the insect was feeding. This beetle remained for long periods suspended at the surface of the water: it was in this exposed position on one occasion for 40 minutes without moving.

XIII. Agabus bipustulatus.

No. 1. Aug. 26th, 1875.—A female specimen observed from 1.51 P.M. till 2.31 P.M. Between these times it rose for purposes of aeration at

1.54, remaining up	8	secs.	2.18, remaining up	8	secs.
2. 6 "	55	"	2.25 "	35	"

No. 2. Sept. 5th.—The same insect again kept close scrutiny upon; and the accompanying notes show the intervals of its appearance at the surface:—

3.22, observation commenced.			4.21, remained up	65	secs.
3.24, remained up	45	secs.	4.34 "	22	"
3.35 "	30	"	4.38 "	17	"
3.43 "	12	"	4.47 "	37	"
3.55 "	21	"	5. 1 "	15	"
4. 6 "	10	"	5. 2, observation ceased.		

The insect buried itself in the mud so that it could not be seen; this it only left for breathing, and descended immediately, except in the case of the small interval 4.34–4.38, when it moved about the bottom instead of concealing itself. The elytra are held very wide open for breathing.

No. 3. The *A. bipustulatus* was again watched at night, and its movements recorded, thus:—

7.42 P.M. observation commenced.

7.48 at surface for	25	secs.
8. 0 "	23	"
8.12 "	77	"
8.22 at surface for	70	secs.
8.37 "	20	"
8.42 ceased observing.		

This observation was made after dark by light of a lamp; the beetle comported itself exactly as in the previous observation made in daylight.

No. 4. Oct. 17th.—The beetle in this instance was fasting; observation commenced at 2.1 P.M. It rose at 2.12 for 25 seconds to breathe, and again at 2.49 for 75 seconds. It otherwise was concealed in the mud. Observation ceased at 3.4 P.M. The beetle was fed at 3.6 P.M.

No. 5. Observation resumed at 4.25; beetle rose at 4.35 for 24 seconds to breathe; again at 4.45 for 95 seconds; and again at 5.6, remaining at the surface 150 seconds. The observation ceased at 5.25.

No. 6. Still later at night, 9.7 P.M., and by artificial light, investigation was renewed. The insect rose to draw in air at

9.14, and up for	15	secs.
9.26 "	80	"
9.36 "	120	"
9.47, and up for	15	secs.
9.59 "	15	"
10. 7 left off inspection.		

The six preceding observations may be thus reduced:—

Obs.	Minutes obs.	Ascents.	Seconds at surface.
No. 1.	40	4	106
" 2.	100	10	274
" 3.	60	5	215
" 4.	63	2	100
" 5.	60	3	269
" 6.	60	5	245
Totals.........	383	29	1209

Summary.—The beetle rose, on an average, about once in $13\frac{1}{3}$ minutes for breathing, and remained, on an average, about $41\frac{2}{3}$ seconds at surface for each respiration. The longest interval observed between two respirations was 37 minutes; but this was an exceptionally long interval. The duration of a respiration

varied from 8 seconds to 150 seconds. The time it was exposed for breathing bore to the time it was not so exposed a ratio of $1 : 19\frac{1}{10}$. The species was observed twice at night, but appeared to be scarcely more active than during the day.

XIV. Acilius sulcatus, var.

No. 1. Sept. 19th, 1875.—A female specimen, rather immature, fasting. Observation commenced at 3.36 P.M..

3.42,	breathed	for an	instant.	4.15,	breathed	for an	instant.
3.46	,,	,,	,,	4.17	,,	,,	,,
3.48	,,	,,	20 seconds.	4.18	,,	,,	,,
3.54	,,	,,	an instant.	4.20	,,	,,	,,
3.57	,,	,,	,,	4.22	,,	,,	50 seconds.
4. 1	,,	,,	,,	4.24	,,	,,	25 ,,
4. 4	,,	,,	,,	4.27	,,	,,	27 ,,
4. 7	,,	,,	,,	4.30	,,	,,	20 ,,
4.10	,,	,,	,,	4.33	,,	,,	20 ,,
4.14	,,	,,	,,				

Observation ceased at 4.36. The instantaneous breathings were performed by rising to the surface, opening wide the breathing-crack and instantly descending; bubbles of gas escaping from the extremity during descent.

No. 2. Sept. 20th.—By lamplight; observation commenced at 8.42 P.M., when the following times of ascent for aeration were observed :—

8.46,	breathing	an instant.	9.16,	breathing	5 secs.
8.48	,,	,,	9.17	,,	15 ,,
8.53	,,	,,	9.20	,,	17 ,,
8.55	,,	,,	9.22	,,	10 ,,
8.58	,,	,,	9.25	,,	30 ,,
8.59	,,	,,	9.26	,,	15 ,,
9. 0	,,	,,	9.30	,,	an instant.
9. 1	,,	45 secs.	9.31	,,	40 secs.
9. 4	,,	15 ,,	9.37	,,	30 ,,
9. 5	,,	25 ,,	9.39	,,	20 ,,
9. 7	,,	15 ,,	9 40	,,	20 ,,
9.10	,,	20 ,,	9.42, observation ceased.		
9.13	,,	22 ,,			

The beetle was not improbably disconcerted by the artificial light. It occasionally progressed slowly by paddling with the middle legs, the hind ones being extended, but almost motionless.

Obs.	Minutes of observation.	Ascents.	Seconds at surface.
No. 1.	60	19	175
„ 2.	60	24	352
Totals ...	120	43	527

Summary.—The beetle rose, on an average, about once in $2\frac{3}{4}$ minutes for breathing, and remained, on an average, about $12\frac{1}{4}$ seconds at surface for each respiration. The longest interval observed between two respirations was 6 minutes; the duration of a respiration varied from a second, or less, to 50 seconds. The time it was exposed for breathing bore to the time it was not so exposed a ratio of $1 : 13\frac{2}{3}$. Only two observations were made, one of them at night, and it was then rather more active than during the day-observation.

XV. Acilius fasciatus.

No. 1. Oct. 17th.—The two specimens, ♂ and ♀, herein mentioned, were not fed for two days. My observations commenced at 2.1 p.m. At 2.46 the male rose, and was at the surface for 5 seconds; whilst the female emerged at 2.49, remaining up for 65 seconds. These beetles moved about but little, keeping themselves much concealed. I left off further notice at 3.1 p.m.

No. 2. The specimens were fed at 3.6 p.m., and observation commenced at 4.25.

The male.	The female.
Rose at 4.43 for 70 secs.	Rose at 5.17 for 55 secs.
„ 5. 5 „ 100 „	„ 5.20 „ 30 „

The beetles were nearly always concealed, and moved about but little. Observation ceased at 5.25.

No. 3. By lamplight, same evening. Observation commenced at 9.7.

The male.	The female.
Rose at 9.21 for 4 minutes, but only occasionally breathing.	Rose at 9.37 for 35 secs.
Rose at 9.35 for 15 secs.	„ 9.57 „ 35 „
„ 9.40 „ 100 „	Observation ceased at 10.37.
„ 9.53 „ 65 „	
„ 10. 0 „ 50 „	
„ 10. 5 „ 105 „	

Obs.	Minutes of observation.	Ascents.	Seconds at surface.
No. 1.	120	2	70
„ 2.	120	4	255
„ 3.	120	8	645
Totals	360	14	970

Summary.—The species rose, on an average, about once in 25¾ minutes for breathing, and remained, on an average, nearly 70 seconds at surface for each respiration. The longest interval observed between two respirations was 52 minutes, and the duration of a respiration varied from 5 to 105 seconds. The time it was exposed for breathing bore to the time it was not so exposed a ratio of 1 : 22¼. It appears probable that the species is more active by night than by day, and that the male is more active than the female.

XVI. Dytiscus marginalis.

No. 1. Aug. 2nd, 1874.—Observation commenced at 7 o'clock P.M. on one ♂ individual of this species.

Rose at 7. 9 for ? secs.	Rose at 7.56 for 70 secs.
„ 7.16 „ 45 „	„ 8. 2 „ 40 „
„ 7.22 „ 85 „	„ 8. 9 „ an instant.
„ 7.36 „ 115 „	„ 8. 9 „ 30 secs.
„ 7.45 „ 15 „	„ 8.15 „ 300 „
„ 7.50 „ 50 „	„ 8.22 „ 65 „

Observation ceased at 8.23 P.M.

No. 2. Aug. 9th, 1874.—Observation commenced at 3.40 P.M., on two males of *D. marginalis*.

Rose at 3.48 for 15 secs.	Rose at 4.22 for 50 secs.
„ 3.48 „ 20 „	„ 4.22 „ 60 „
„ 3.51 „ 5 „	„ 4.24 „ 5 „

Rose at 3.53 for 35 secs.	Rose at 4.27 for 30 secs.
„ 3.56 „ 40 „	„ 4.29 „ 25 „
„ 3.59 „ 45 „	„ 4.31 „ 120 „
„ 4. 3 „ 20 „	„ 4.34 „ an instant.
„ 4. 4 „ 20 „	„ 4.35 „ 115 secs.
„ 4.12 „ 45 „	„ 4.40 „ 140 „
„ 4.12 „ 90 „	

Observation ceased at 4.43 P.M.

No. 3. Aug. ?, 1874.—Observation commenced at 2.31 P.M. on one ♂ *D. marginalis*.

Rose at 2.50 for 2 secs.	Rose at 3.26 for 5 secs.
„ 2.56 „ 35 „	„ 3.38 „ 97 „
„ 3. 9 „ 60 „	„ 3.57 „ 97 „

Observation ceased at 4.11 P.M.

Obs.	Minutes of observation.	Ascents.	Seconds at surface.
No. 1	83	12	816
„ 2	126	19	881
„ 3	100	6	296
Totals ...	309	37	1993

Summary.—The male of *D. marginalis* rose, on an average, once in about 8⅓ minutes for breathing; and remained, on an average, about 54 seconds at surface for each respiration. The longest interval it was observed to pass without breathing was 19 minutes. The duration of a respiration varied from 5 seconds to 300 seconds; and the time it was exposed bore to the time it was quiescent a ratio of 1 : 9⅓.

XVII. Dytiscus marginalis, ♀.

No. 1. Aug. 2nd, 1874.—Observation commenced at 7 P.M. on one female.

Rose at 7. 8 for 20 secs.	Rose at 7.50 for an instant.
„ 7.22 „ 80 „	„ 7.54 „ 80 secs.
„ 7.38 „ 100 „	„ 8.15 „ 280 „

Observation ceased at 8.23 P.M.

No. 2. Aug. 9th, 1874.—Observation commenced at 3.40 P.M. on two females of *D. marginalis* :—

Rose at 3.51	for	5 secs.	Rose at 4.12	for	50 secs.
„ 3.55	„	an instant.	„ 4.23	„	90 „
„ 3.59	„	„	„ 4.28	„	an instant.
„ 3.59	„	65 secs.	„ 4.29	„	15 secs.
„ 3.60	„	25 „	„ 4.33	„	70 „
„ 4. 3	„	an instant.	„ 4.35	„	110 „
„ 4. 4	„	80 secs.	„ 4.39	„	70 „

Observation ceased at 4.43 P.M.

No. 3. Aug. ?, 1874.—Observation commenced on one individual of *D. marginalis*, ♀, at 2.31 P.M.

Rose at 2.56	for	35 secs.	Rose at 3.42	for	3 secs.
„ 3. 8	„	90 „	„ 3.46	„	65 „

Observation ceased at 4.11.

Obs.	Minutes of observation.	Ascents.	Seconds at surface.
No. 1.	83	6	561
„ 2.	126	14	584
„ 3.	100	4	193
Totals ...	309	24	1338

Summary.—The female of *D. marginalis*, rose, on the average, once in about $12\frac{7}{8}$ minutes for breathing, and remained, on an average, about $55\frac{1}{2}$ seconds at surface for each respiration. The longest interval it was observed to pass without breathing was $32\frac{1}{2}$ minutes. The duration of a respiration was from 3 seconds to 280 seconds. And the time it was exposed bore to the time it was quiescent a ratio of $1:13\frac{4}{5}$.

On *Actæomorpha erosa*, a new Genus and Species of Crustacea. By Edward J. Miers, F.L.S., Assistant in the Zoological Department, British Museum.

[Read December 21, 1876.]

(Plate XIV.)

The remarkable Crustacean here described was brought up by the dredge from a depth of 7 fathoms with a number of other small Crustacea, chiefly *Cancroidea*. On account of its small size and external resemblance to certain species of *Cancridæ*, its true posi-

tion among the *Oxystomata* was unsuspected' until my paper on the Oxystomatous Crustacea had been read before the Society.

ACTÆOMORPHA, gen. nov.

Carapace convex, with the antero-lateral margins arcuate, as in the *Cancroidea*; front broad, and slightly concave in front. External antennæ with the basal joint apparently fused with the inferior wall of the orbit; the flagellum wanting; the orbital cavity large, and filled with the peduncles of the eyes, the cornea being almost completely concealed by the external wall of the orbit. Buccal cavity broader and less decidedly triangulate than is usual in the *Oxystomata*. External maxillipeds with the meros-joint triangular, a little shorter than the ischium-joint; the exognath narrow, and with its outer margin slightly curved. Abdomen of male narrow-ovate, 7-jointed, the two last joints longer than the preceding, the terminal joint triangular, acute.

ACTÆOMORPHA EROSA, sp. nov.

Carapace everywhere granulated, the granules interspersed with small deep pits. There is a large rounded elevation behind each orbit, one on the cardiac region, and one on each branchial region near the lateral margin. Anterior legs obscurely granulated, robust; arm very short; hand but little longer than the wrist, fingers straight, closely meeting along their inner edges when closed, acute at the tips. Ambulatory legs short, nearly smooth, laterally compressed; tarsi very small, slender, and acute. Length 4 lines; breadth $4\frac{1}{2}$ lines.

Hab. Australia, Port Curtis (F. M. Rayner, Esq.).

This species, of which I have seen but a single example, is distinguished from all the *Leucosiidæ* with which I am acquainted by its form and the structure of the external antennæ and of the orbital region. In general appearance *A. erosa* bears a greater resemblance to such a species as *Actæa granulata* among the *Cancridæ* than to the *Oxystomata* (hence its name); and this resemblance is borne out by the form of the large orbits, and short robust, anterior legs. That it really belongs to the *Oxystomata* is evident from the form of the buccal cavity and of the meros-joint of the outer foot-jaws. The eyes, of which the cornea is rudimentary (and nearly concealed, in the specimen I have examined, by the outer wall of the orbit), are perhaps useless as organs of vision. Notwithstanding its small size, this example shows no signs of immaturity.

It is perhaps most nearly allied to the genera *Oreophorus** and

* *Oreophorus*, Rüppell, Beschreib. 24 Krabben Rothen Meeres, p. 19 (1830); Bell, Trans. Linn. Soc. xxi. p. 306 (1855).

*Spelæophorus**, which it resembles in the arcuate antero-lateral margins of the carapace and well-defined orbits; but it differs in the postero-lateral margins of the carapace not being produced over the bases of the ambulatory legs, in the form of the eye-peduncles and anterior legs, &c.

EXPLANATION OF PLATE XIV.

Fig. 1. *Actæomorpha erosa* ♂, nat. size (outline).
2. A dorsal view of the same animal, enlarged about four times.
3. An inferior view, also × 4 diam., and with limbs extended.
4. The inferior aspect of fore parts, greatly enlarged, showing eyes (*a*), inner antennæ (*b*), and outer antennæ (*c*).
5. The orbit viewed from above, showing the position of the eye-peduncle (*a*), enlarged.
6. The hand, exterior view, enlarged.

Morphology of the Mammalian *Ossicula auditûs*. By Alban H. G. Doran, F.R.C.S. (Communicated by Professor Flower, F.R.S., F.L.S.)

[Read December 21, 1876.]

(Abstract.)

The complete memoir on the small ear-bones of the Mammals will hereafter be published in the Society's 'Transactions,' with copious illustrations, whereby an excellent comparison of the various forms peculiar to and significant of groups may be instituted. Previously elsewhere† I have given a short *résumé* respecting the material which has afforded the means of study of the series, with a brief reference to what has already been published on the internal auditory apparatus, and added a short notice concerning points among certain of the higher groups of the Mammalia. For the present abstract I shall therefore confine my remarks to the auditory ossicles of the following orders, viz.:—the Insectivora, the Chiroptera, the Cetacea, the Sirenia, the Edentata, the Marsupialia, and the Monotremata.

* *Spelæophorus*, Alph. M.-Edw. Ann. Soc. Ent. France (sér. 4), v. p. 148 (1865).

† Proc. Roy. Soc. vol. xxv. pp. 101–109 (1876).

In the ossicula of the Insectivora no constant positive character can be found. These bones are most specialized in *Chrysochloris.* Careful examination shows that the singular malleus in this genus is modified rather from the higher or anthropoid form than from the more central laminated type. The ossicula of *Galeopithecus* are very generalized; in its malleus it approaches the Macroscelidæ, in the incus it resembles *Tupaia*; in the latter the malleus assumes the neckless character common among the Cebidæ, and observed in some Lemurs and in *Sciurus.* Taken as a whole, the ear-bones of *Tupaia* are higher in type than those of any other animal in this order.

In the Macroscelidæ the extremely constricted neck of the malleus with its narrow lamina and its processus gracilis running straight forwards to the Glaserian fissure are highly characteristic; but in *Petrodromus* the malleus more resembles that of *Sorex* than the same ossicle in *Macroscelides* and *Rhynchocyon.*

In the Soricidæ, Myogalidæ, Talpidæ, Centetidæ, and Erinaceidæ one common feature exists, a malleus with a wide lamina, and a processus gracilis united to the tympanic ring after the fashion of the Marsupials. The processus brevis of the incus is always ill developed except in the Centetidæ and *Gymnura*; the intercrural aperture of the stapes is wide. In the Shrews the malleus bears both a processus muscularis and a peculiar orbicular apophysis, as in *Mus*; this spherical process in *Myogale* appears to replace functionally the processus muscularis, which is absent in that genus.

In the Talpidæ the malleus of *Condylura* most resembles that of *Sorex*; but its orbicular process serves as a processus muscularis, as in *Myogale.* The mallei in *Talpa* and *Scalops* closely resemble each other; but the incus of *Scalops* has not the broad channelled processus longus seen in *Talpa* and *Condylura.* In the Erinaceidæ and Centetidæ the malleus has a broad processus gracilis perforated to transmit the chorda tympani nerve. The processus muscularis and an ill-developed orbicular apophysis coexist.

The ossicula of the Chiroptera resemble those of the Soricidæ and allied Insectivora very strongly, except in *Pteropus*, where the malleus is of a rather lower type. A well-developed processus muscularis is always found in the insectivorous Bats; in *Phyllorhina* and other genera there is another process accessory

to it; an orbicular apophysis, observed in *Sorex*, is also constant, but not pedunculated. The manubrium is quadrilateral, the inner as well as the outer aspect being sharply bordered off from each of the sides. The incus is very similar to that of the Shrews and Marsupials: the stapes is of a rather higher type than the other ossicula; its aperture is generally wide and occupied in the recent skull by a small artery unsupported by any bony canal.

In the Cetacea the malleus is constantly united to the tympanic bone by firm bony ankylosis through the medium of the processus gracilis. The manubrium is ill developed or completely suppressed. The stapedial crus of the incus is greatly developed. The crura of the stapes are thick and encroach upon or obliterate the aperture. This ossicle always fits firmly into the fenestra ovalis, to which it is in no species constantly ankylosed.

These bones are most generalized in type in the genus *Balæna*, particularly as regards the incus; the malleus, too, has the least-modified form of manubrium. Next in order come *Neobalæna* and *Megaptera*; but *Balænoptera* possesses a malleus and incus as modified as in the Dolphins. In the Physeteridæ the malleus is extremely modified, the manubrium and processus muscularis are not borne upon a tubercle projecting from the front of the head as in other Cetacea, but are reduced to two small spines. That representing the manubrium is almost obsolete in *Physeter*, *Hyperoodon*, and *Mesoplodon*, but fairly developed in *Berardius*. The incus has characters intermediate between the same in *Balæna* and *Delphinus*; the stapes assumes a tolerably distinctive form.

In all the Dolphins the incus has a very large stapedial crus and a stapes with stouter crura than in the Whale-bone and Sperm-Whales. The malleus resembles considerably that of *Balænoptera*; the manubrium may be represented by a spine bent downwards (*Orca*, *Pseudorca*) or depressed against the side of the ossicle (*Globiocephalus*, *Lagenorhynchus*, *Phocæna*); or that spine may be almost or quite obsolete (*Delphinus*, *Delphinapterus*): part of the process from the membrana tympani is inserted along a narrow groove in the tubercle. *Monodon* has a spine-like manubrium, but differs from the other Dolphins in the characters of its articular surface and the length of the head and tubercle. The head of the malleus is best developed in *Orca*.

Platanista is distinguished from the above delphinoid Cetaceans by the great length of the process from the head of the malleus, and by other less conspicuous modifications in that ossicle. Such distinctions are hardly discernible in the genus *Inia.*

In the Sirenia the ossicula are modified more in texture, weight, and outline than in the development or suppression of any of their processes as in the Cetacea. Their singular general modifications of form mask any points of resemblance to their representatives in any other order which otherwise might be observable, excepting that in *Halicore* and, apparently, in *Halitherium* there is an approach to a quadrilateral form of stapes, which at least reminds the anatomist of the form of that bone in the larger Ruminants. In no respect do any of the ossicula resemble those of the Whales and Dolphins. *Halicore* differs distinctly from *Manatus* in several particulars, most of which have been already described by Hyrtl. In *Rhytina* the malleus and incus, judging from the description and figures given by Clausius, very closely resemble those of the Manatee. In *Halitherium* the description of the ossicula with which Dr. Krauss has favoured science leads me to consider that the malleus is intermediate in type between those of *Manatus* and *Halicore,* the incus more resembling that of the former Sirenian.

In the Bradypodidæ, among the Edentata, the characters of the malleus and incus are fairly generalized, whilst the stapes assumes, to a certain extent, Sauropsidan characters. Among the Armadillos the genera *Dasypus* and *Tatusia* present much higher characters in the ossicula of adult specimens than can be found in *Priodon* and *Tolypeutes.* The malleus in the adults of the two latter genera resemble the same ossicles in the fully developed fœtus of *Dasypus* and *Tatusia.* This recalls an identical condition in *Bos* and *Ovis.*

In the Manidæ the ossicula possess the most positive characters among all the Edentata. The malleus is more specialized than in the other groups, and the stapes is more absolutely columelliform than in any other placental mammal. In the Anteaters the malleus may be known from that of other Edentata by the form of its head; in *Cyclothurus* it resembles that of *Bradypus* more than do the same bones in *Myrmecophaga* and *Tamandua.*

In *Orycteropus* the malleus is quite unlike that of any true Ant-eater, but resembles, to a certain extent, that of *Priodon,* from which, however, it maintains very distinctive features.

The Marsupialia are distinguished for the uniformly low type of their ossicula, although no single feature indicating inferior grade in them is not to be found, in isolated cases, in higher mammals. These bones are of the most ill-developed consistence in the Peramelidæ, and of the highest form in the Didelphyidæ, where the incus has a well-developed processus brevis, and the stapes, alone among Marsupials, is perfectly bicrurate. In the Kangaroos the ossicula are central in character, the malleus bears a large foliaceous processus gracilis, as in the Wombat; but the stapes is always partially bicrurate. In the Phalangistidæ the stapes is generally columelliform, or only slightly bicrurate, the incus is of as high a type as in the American Opossum, the malleus is of the form seen in a new-born *Macropus*; this ossicle has distinctive features in *Phascolarctos*.

In the Wombats the malleus is not so much of high type as an extreme form of the development of that bone in *Macropus*. The incus has a stapedial crus somewhat like that of *Perameles*; the stapes is always columelliform. In tne Dasyures, including *Phascogale* and *Myrmecobius*, the incus is of low type, and the stapes columelliform; but all their ossicles are of more solid consistence than in the Bandicoots.

The distinguishing features in the ossicula of the Monotremata are a peculiar form of articulation between the malleus and incus by means of a scale-like development from the head of the former, and the presence of an absolutely columelliform stapes. Yet the three ossicula are not much modified from their representatives in the lower Marsupials. The incus is ankylosed to the malleus in *Echidna* and generally in the adult *Ornithorhynchus*, but not in the same manner as in certain Rodents. These bones are of more solid consistence in *Echidna* than in the other Monotreme. In all cases among mammals where the stapes is columelliform, it clearly represents the entire bicrurate stapes of most animals in that class, but, according to the most recent views of embryologists, only a part of the columella of birds and reptiles, the greater part of that long ossicle in the latter classes probably representing the long process, or at least some other portion, of the incus.

An Account of some new Species, Varieties, and Monstrous Forms of Medusæ.—II. By George J. Romanes, M.A., F.L.S., &c.

[Read January 18, 1877.]

(Plates XV. & XVI.)

In my previous communication on this subject (Journ. Linn. Soc., Zool. vol. xii. pp. 525–531) I omitted to give any drawings of the new species of Medusæ which I described. On the present occasion, therefore, I supply this omission by representing in Plate XV. such of the previously described Medusæ as are undoubtedly entitled to rank as new species. These are the three species of the genus *Tiaropsis*, viz. those represented in figs. 1, 3, and 4. The Plate also contains figures of the two species of *Thaumantias* (figs. 2 and 5) which I happened to meet with last summer. There can be no doubt that these are true species; and for them I propose the name *T. crucifera* and *T. helicobostrycha**.

Proceeding now to describe the monstrous forms of Medusæ which have this year fallen within my observation, I have, in the first place, to reiterate the surprise which I expressed in my previous paper at the extreme rarity of such forms—so far, at least, as the naked-eyed group are concerned. Looking to the lowly type of organization which the Medusæ present, remembering how prone these animals are to exhibit the phenomenon of gemmation, and considering that even in much higher animals so-called "vegetative reproduction of similar parts" is a process of comparatively frequent occurrence, considering these points, I think we should be prepared to expect the Medusæ to present us with numerous examples of monstrous or misshapen forms. Yet so far is this from being the case that this year, as last year, I have only met with one solitary instance of departure from the normal type among the many thousands of naked-eyed Medusæ which I observed. This instance again occurred in the genus *Sarsia*; but, unlike the monstrosity described in my former paper, in which there were six complete segments, in the present instance there were

* In my former paper I assigned to a probably new species the name *Bougainvillea fruticosa*. Having since ascertained that this name had already been appropriated by Prof. Allman to designate another species of the same genus, I will now substitute for it the name *B. Allmanii*.

only five segments. These, however, were all complete and exactly equal to one another.

In the case of *Aurelia aurita* deviations from the normal type are of frequent occurrence. It is remarkable, however, as pointed out in my former paper, that such deviations nearly always take place in the direction either of multiplication or of abortion of *entire segments.* As I have this year paid particular attention to this subject, I will here describe all the more noteworthy forms of variation which I have observed: and to render my description intelligible, it is necessary to begin by describing the normal type.

Fig. 6 (Pl. XV.) represents *Aurelia aurita* in full diastole, with its manubrium removed. It will be observed that the organism is constructed on what we may metaphorically term a very definite plan. The ovaries are four in number, equal in size, and arranged symmetrically round the centre of the animal. The lithocysts, or ganglia, are eight in number, and are disposed round the margin of the animal at points equidistant from one another. These eight organs thus bear a very precise geometrical relation to the four central organs; and this relation is, as it were, mapped out by the distribution of the radial tubes. For it may he observed by a glance at the diagram that although most of the nutrient tubes branch and anastomose as they proceed from the centre to the circumference of the umbrella, there is a marked exception to this mode of distribution in the case of some of these tubes—those, namely, which proceed from the centre to the circumference in perfectly straight or radial lines without branching. Moreover, closer inspection will show that these radial or unbranching tubes are disposed with perfect symmetry. For one such tube passes radially to each of the eight marginal ganglia, and each of the eight segments of the circle thus marked out is bisected by another radial or unbranched tube. There are thus altogether sixteen radial or unbranched tubes, which serve to mark out the whole umbrella into as many equal segments. It must further be observed that those straight tubes which proceed to the marginal ganglia differ from those which alternate with them in being less deeply coloured. Lastly, I may add that in the normal type of *Aurelia* the manubrium (which is not represented in the figures) presents four equal lobes.

Such being the normal type of *Aurelia*, the following are the more important deviations from it which I have observed. The most usual is that which I described in my former paper, and

which is here represented in fig. 7 (Pl. XV.). It will be seen that all parts of the organism have undergone multiplication in a common ratio ; so that the effect is to "increase the *number* whilst adhering to the *type* of the natural segments above alluded to," and this without in the least degree destroying the general symmetry of the animal. In such cases the manubrium is usually six-lobed. In other cases, however, some one or more of the normal segments do not take part in the multiplication ; so that while the number of segments are increased and their natural type conformed to, the animal nevertheless, as a whole, becomes asymmetrical. Of such a case fig. 8 (Pl. XV.) may be taken as an example.

It will be observed that in the last figured specimen the ovaries were not affected by the process of multiplication, although this had affected both the manubrium and the segments of the umbella. Such an immunity from the abnormal process in question is frequently presented, both by the ovaries and by the manubrium, even in cases where it has affected the umbrella to a large extent. This may be seen in fig. 9 (Pl. XV.), where it is also worth while to observe the *symmetrical* manner in which the multiplying process has affected the umbrella regarded as a whole. In fig. 1 (Pl. XVI.) we have an exactly similar case, except that the multiplying process has failed to extend to one of the quadrants of the umbrella.

In some cases the multiplication of parts takes place on one side of the umbrella only, as may be seen in figs. 2 and 3 (Pl. XVI.). In the first of these specimens one of the ovaries has become duplicated; and all the other parts in its segment having done the same, the manubrium presented five lobes, and the umbrella ten segments. In fig. 3 one of the ovaries has become tripled ; and the other parts of the umbrella being multiplied in the same manner, the total number of segments is twelve. The manubrium, however, in this case only presented the same number of lobes as in the last one.

Abortion of parts in *Aurelia* takes place in the same symmetrical way as does multiplication of parts. For instance, in fig. 4 (Pl. XVI.) it is observable that one ovary is absent, while the segments of the umbrella are reduced to six. Similarly, in fig. 5 (Pl. XVI.) the ovaries and segments of the umbrella are reduced to one half of the normal number. In neither of these specimens, however, was the manubrium affected by the reducing process.

I have now given a sufficient number of illustrations to render an accurate idea of the various ways in which the normal type of *Aurelia* is seen to be modified by the multiplication and the suppression of parts. The most remarkable point with regard to

such cases is the strictly symmetrical manner in which the abnormal developments or abortions are usually found to occur. In most cases these developments, or abortions, extend proportionally to all parts of the organism. In other cases this is not so; and of these cases the most numerous are those in which the ovaries and manubrium are unaffected, while the segments of the umbrella are multiplied. In some cases, on the other hand, a deficiency or absence of the ovaries entails no corresponding deficiency or absence of any of the other organs. Lastly, it may be added that in every case of multiplication of segments which I have ever seen, the supernumerary lithocysts always occurred at the end of a faintly coloured radial tube, and never at the end of a strongly coloured one. Whether the marked difference in the coloration of the two sets of radial tubes implies any corresponding difference in their physiological functions, is a point which I have not been able to ascertain; but if such is the case, I should be inclined to suspect, from the uniform rule just mentioned, that whatever peculiarity of function it is which renders necessary the high coloration of the radial tubes that alternate with the lithocysts, is a peculiarity which is incompatible with the presence of a lithocyst at the end of the tube.

From the additional observations detailed in this paper, it will be evident that no stress is to be laid on the fact of the *most usual* form of multiplication of parts in *Aurelia* being proportionally the same as that which appears to be the *most usual* form of multiplication in *Sarsia* (see former paper, p. 529).

This year, as last year, I observed "that towards the end of August all the individuals of this species (i. e. *Aurelia aurita*) began to undergo a marked diminution in size." In my previous communication I expressed myself in favour of the view that this progressive diminution in the size of individuals composing the incoming generations of *Aurelia* was due to the increasing numbers of a parasitical Crustacean (*Hyperia galba*), "which appeared to devour with avidity all the coloured parts of their hosts." There can, I still think, be little doubt that such parasites, by impairing or destroying the nutritive system of these Medusæ, must hinder, or entirely stop, the growth of the latter; but that the small size of *Aurelia* towards the end of the season is not to be attributed to this cause alone, I have during the present autumn obtained satisfactory evidence. For this year the numbers of *Hyperia galba* were not nearly so great as they were last year; so that I am now better able to determine how much

of the effect which we are considering is to be attributed to their influence. And forasmuch as I observed that towards the end of the season the Medusæ were of small size, whether or not they were infested by the parasites in question, I conclude that causes other than the one which I previously mentioned must be chiefly concerned in producing this effect.

DESCRIPTION OF PLATES.

Plate XV.

Fig. 1. *Tiaropsis indicans*, n. sp. Natural size.

2. *Thaumantias crucifera*, n. sp. Natural size.
3. *Tiaropsis polydiademata*, n. sp, Natural size and colour.
4. *Tiaropsis oligoplocama*, n. sp. Natural size.
5. *Thaumantias helicobostrycha*, n. sp. Natural size.
6. Diagrammatic representation of the ovaries and nutrient tubes as they occur in a normal specimen of *Aurelia aurita*. The manubrium, which normally presents four lobes, has been removed.
7. Diagrammatic representation of a specimen of *A. aurita*, which presented an abnormal, though symmetrical, multiplication of parts—there being twelve complete segments instead of eight (as in fig. 6), and the manubrium, which is not shown, having presented six lobes instead of four.
8. Diagrammatic representation of an asymmetrical multiplication of parts in *A. aurita*. In this specimen the manubrium was bifid in the lobes which faced one of the multiplied segments.
9. Diagrammatic representation of an abnormal, though symmetrical, multiplication of nutrient tubes in *A. aurita*—those in every alternate segment having undergone duplication. In this instance the manubrium resembled the ovaries in not partaking of the duplication.

Plate XVI.

Fig. 1. Diagrammatic representation of a specimen of *A. aurita*, resembling that figured in Pl. XV. fig. 9, except that one of the four normal quadrants of the umbrella has escaped the process of duplication.

2. Diagrammatic representation of an asymmetrical multiplication of parts n *A. aurita*, one of the four quadrants of the animal having become duplicated. In this instance, however, the manubrium was four-lobed.
3. Diagrammatic representation of another form of asymmetrical multiplication of parts in *A. aurita*, one of the four quadrants of the animal having become tripled. In this instance the lobe of the manubrium which faced the tripled quadrant of the umbrella was doubled.
4. Diagrammatic representation of an abortion of parts in *A. aurita*, one of the four quadrants of the animal having been suppressed. In this instance, however, the manubrium presented its normal number of lobes.
5. Diagrammatic representation of a still further abortion of parts in *A. aurita*, two of the four quadrants having been suppressed. In this instance also, the manubrium presented its normal number of lobes.

On the Male Genital Armature in the European Rhopalocera.
By Dr. F. Buchanan White, F.L.S. &c.

[Read December 21, 1876.]

(Abstract.)

In several orders of the Insecta the structure of the organs upon which the perpetuation of the species depends has afforded, in very many cases, the best and surest characters for the discrimination of species. But in the Lepidoptera, one of the largest of the orders, and that on which perhaps the greatest amount of attention (scientific or otherwise) has been bestowed, the structure of these parts has not received the consideration it deserves, but has been almost entirely ignored.

The author in confining himself to the European forms is not prepared to admit that his conclusions thereon will hold good with the Lepidoptera in general, though there are certain indications that it may.

He has selected *Epinephele hyperantus*, L., as a type or standard, and describes its apical segment, noting that in this and all cases it is necessary to clear away the scales and hairs for a clear and satisfactory view of the parts to be obtained. The appendages are three, viz. a superior and two lateral ones. To the latter he applies the name "harpagones," though possibly equivalents of the *appendices inferiores* in Trichoptera. The upper appendage he designates "tegumen;" and he takes notice of the relations of all three to the anal opening and intromittent organ &c.

He has discussed the structure of the apical segment, and its modifications in various families, the nature and varied character of the tegumen and of the harpagones, comparing the resemblances and differences in groups. From these data he then traces the apparent affinities as derived from the said characters, and gives it as his opinion that not only do they yield good generic distinctions, but that in many cases specific differentiation is very appreciable. In his researches the author has made a great number of sketches, which illustrations render comparison relatively easy. These and the complete paper will hereafter be published in the Society's 'Transactions.'

The Butterflies of Malacca. By ARTHUR GARDINER BUTLER, F.L.S., F.Z.S., Senior Assistant in the Zoological Department, British Museum.

[Read December 21, 1876.]

(Abstract.)

THE author has already, in a brief communication (Journ. Linn. Soc. no. 67, vol. xiii. p. 115), given a preliminary notice of two new species of Lepidoptera from Malacca, and mentioned the donor and circumstances which have enabled him to draw up an extended list, with annexed remarks on geographical distribution. It is only necessary to add that the paper, with figures of the new and more remarkable forms, will subsequently appear in the Society's 'Transactions.'

It would seem that of 280 species of determinable Lepidoptera collected by Capt. Pinwill, 43 are new or hitherto unnamed species, as follows:—

Euplœa Pinwillii, male and female, allied to E. ménétriésii.
Calliplœa leucogonis, female, nearly allied to E. vestigiata.
Hestia linteata, male and fenale, nearly allied to H. belia.
Yphthima corticaria, male and female, allied to Y. nareda.
Thaumantis pseudaliris, male, with affinities to T. aliris.
Athyma nivifera, ♂ and ♀, bearing resemblances to A. nefte.
A. clerica, male, nearly allied to A. abiassa.
Neptis mamaja, male and female, nearly allied to N. eurynome.
N. leuconota, female, distinguishable from N. nata.
N. gononata, male, intermediate in character between N. nata and N. soma.
N. dorelia, male and female, with differences from N. tiga.
N. peraka, male and female, somewhat resembling N. heliodora.
N. dindinga, female, a large and well-marked species.
Diadema incommoda, male, approaching to D. bolina and female to D. nerina.
Cethosia methypsea, male, allied to C. hypsina and C. penthesilia.
Cirrochroa rotundata, male, nearly allied to C. mithila.
Cynthia erotella, ♂ and ♀, smaller than, but allied to, C. erota.
Parthenos lilacinus, male and female, bears resemblances to Minetra gambrisius.
Castalius ethion, female, not unlike C. roxus.
Lampides pseudelpis, male, nearly allied to L. elpis.

Catargyra elegans, male, allied to genera Lampides and Miletus.
Delias metarete, male and female, nearly allied to D. hyparete.
Appias plana, male, with constant differences from A. leptis.
Ornithoptera ruficollis, male, allied to O. flavicollis.
Papilio Esperi, male and female, having close affinities with P. mestor and P. achates.
Cobalus ciliatus, female, expanse of wings 1 inch 7 lines.
Pamphila mæsoides, male and female, resembling P. mæsa.
Astictopterus gemmifer, male and female, several examples.
A. stellifer, male, much like a small A. jama.
Plesioneura asmara, male and female, similar to P. dan.
P. Pinwillii, male, most nearly allied to P. tabrica.
Tagiades calligana, male and female, closely allied to T. atticus.
T. lavata, male, allied to T. pralaya.
Callidula abisara, male, nearly allied to C. sakuni.
Amesia juvenis, male, most nearly allied to A. venusta.
A. pexifascia, female, the most striking species in the genus.
Laurion corculum, male, expanse of wings 1 inch 1 line.
Birnara nubila, female, allied to Pantana bicolor.
Kettelia Lowii, female, new genus allied to Penora.
Orgyia turbata, female, expanse of wings $11\frac{1}{2}$ lines.
Nyctalemon docile, male and female, a local representative of N. hector.
Urapteryx marginipennis, male, approaches U. crocopterata.
Glyphodes amethysta, male, expanse of wings 1 inch 2 lines.

Of the 258 species now registered from Malacca, thirty-six appear to be endemic; of the remainder rather more than a fourth occur either at Assam or Nepal, more than a seventh at Moulmein, less than a seventh at Ceylon, nearly two fifths (apparently) in the island of Penang, about two elevenths at Singapore, about three sevenths in Borneo, about three sixteenths in Sumatra, more than a third in Java, about two thirteenths in Siam, rather more than a tenth in China, two species in the New Hebrides, and six in Australia. Thus Malaccan Butterflies preponderate towards those of the Indian region.

On Amphibious and Migratory Fishes of Asia.

By Francis Day, Esq., F.L.S.

[Read January 18, 1877.]

Nearly nine years since (May 14th, 1868) I laid before the Zoological Society of London the results of some investigations which I had made in Madras respecting the modes of respiration amongst Indian freshwater fishes. Since that time, although more facts have come to my notice, materials have scarcely been sufficient to enable me positively to prove the amphibious nature of some of these inhabitants of the waters of the plains of Asia.

Now, however, mainly due to the assistance I have received from several friends, more especially Dr. Hubrecht of Leyden, I think that the period has arrived when I may venture again to request attention to the facts which I have collected, in the hope that comparative anatomists who have sufficient leisure will more fully investigate the anatomical details.

The existence of fishes in Tropical Asia having amphibious manners has long been known; but that they are amphibious, in the true sense of the word, appears to be doubted by a portion, at least, of the scientific world. Professor Huxley has remarked "that there are some fishes which, besides gills, possess an apparatus for breathing air directly. This apparatus, represented by the air-bladder of ordinary fishes, first takes on its new character and becomes a lung in that remarkable genus *Ceratodus*, in which it exists as a large cellular structure situated in the upper part of the abdominal cavity just under the vertebral column, and connected with the gullet by a slit (the glottis), by means of which the fish can pass air from the mouth into the lungs. It is not, however, this peculiarity of opening into the œsophagus which constitutes a lung; for the air-bladder of many fishes possesses an open duct of a similar nature: the great distinguishing feature is, that the blood taken to this bladder does not pass into the ordinary venous channels, but is returned immediately to the heart in a purified condition by a special vein." ('Nature,' March 23, 1876, p. 411.)

The above extract would appear to advance the three following propositions:—

First. That in fishes we first perceive the swim-bladder assum-

ing the functional character of a lung in the genus *Ceratodus*, rendering it amphibious.

Secondly. That this respiratory sac, which has the functional character of a lung, is the homologue of the air-bladder or swim-bladder of ordinary fishes.

Thirdly. That the distinguishing character of an amphibious fish is that the blood is purified at a respiratory organ distinct from the gills, receiving venous but returning arterial blood into the general circulation.

I propose in the present communication adverting more particularly to the following points:—

First. That there are fishes in Asia which normally respire atmospheric air direct.

Secondly. That these fishes possess respiratory organs having a lung-like function, and which are distinct from the gills.

Thirdly. That they are essentially amphibious, as their accessory respiratory organs receive venous and return arterial blood into the general circulation without such passing through the branchiæ or gills.

Fourthly. That this accessory respiratory sac is certainly not homologous with the swim-bladder of fishes, but may be with the respiratory sac of amphibious reptiles.

Prior to discussing these points I propose briefly relating how I have been led, step by step, to these conclusions.

Ten years since, having failed in my experiment of attempting to introduce Trout by means of their ova into the waters of the Neilgherry hills in Madras, I obtained the sanction of Government to try whether fish from the plains would succeed. At first I had great difficulty in conveying them alive, when a native suggested mixing mud with the water, and in this way many Ophiocephalidæ were carried in safety up the hills.

As it appeared to me that the existence of mud in large quantities in water would tend more to the destruction than preservation of the lives of fishes, by choking the gills and impeding circulation, I was at a loss for an explanation. The native reason was that they could not beat themselves about so much, an argument which seemed hardly sufficient to explain the circumstances.

During the monsoon months, when enormous quantities of rain-water descend from the hills to the rivers of the plains, the fish are often seen dead in large numbers, due either to the water

being poisoned from the vegetation, or simply to its being fouled, preventing respiration by choking the gills. If the dead fish are examined, it will be found that poisoned water kills all kinds of fish, fouled water only those which have no accessory means of respiration, in fact all which are not amphibious.

The collector of Bustee reported, in answer to my inquiries, "The Bela Tal at Jeitpur is formed by an embankment across a low valley, and the course of a small hill-stream lies through it. During the hot weather this stream becomes almost dry, only retaining water in holes in the midst of the jungle; these holes become full of dead leaves, and with the first burst of the rains the putrid contents are swept down into the lake. The consequence, I was told on the spot, is that numbers of fish are perfectly stupified and float on the top of the water, an easy prey to any who will take them." Mr. Hobart likewise observed, "I have never heard of poisoning being used as a means to capture fish there; but I remember seeing the stream poisoned naturally. At the end of the cold season some rain had fallen and had washed the fresh leaves into the water, which turned, from this and other causes, to a dull red colour. The fish sickened and died in thousands. On the up-stream side of the arches of the bridges and traps (weirs spanning the river) you could see millions of fish eager to get down past the obstruction and escape from the poisoned water. For a hundred yards or so the river was a mass of living heads. The fish died in a day or two, and birds of prey came from all parts to devour them. The dead fish were carted off as manure."

The Tehsildar of Buldana, in the assigned districts of the Deccan, observed that "disturbing the water of a stream so as to cause it to become muddy is said sometimes to cause the fish to die." The Collector of Tanna in Bombay remarked that when the rivers become muddy at the commencement of the monsoon, fish die in large numbers, also when they become nearly dry at the close of the hot weather. In Oudh it was reported from Faizabad that fish were captured by the water being first mudded by gangs of fifty or sixty men. In fact, I saw the same thing this last year in Ireland. The water was low; some cattle went into a small pond formed by the stream above having ceased to flow, and two Trout were thus destroyed.

On the other hand, in 1866, I was riding from Mettapolliam to Wellington, and whilst crossing the Kullaar bridge, at 4.45 P.M.,

obtained a young *Ophiocephalus gachua* (an amphibious fish). I wrapped it up in a wet pocket-handkerchief and carried it up an ascent of 5000 feet, only moistening the handkerchief twice by the way. In four hours I reached my destination; and my companion was none the worse for its journey. In Burma the fishermen are practically acquainted with the fact that some fish, as these Ophiocephalidæ, are air-breathers. When they wish to fish some of their ponds, they let out all the water they are able, when perhaps the sole visible contents are five feet of slimy mud through which their bamboo net (*gyan*) has been drawn. Though no fish are now to be seen, they are well aware that many fine ones remain; so they take a large sail or mat and spread it over the mud. After a time this is removed; amphibious fishes are seen stupefied, and so are easily captured, their blood having become carbonized, due to the impossibility of their obtaining access to the atmospheric air for the purpose of respiration.

The *Anabas scandens*, or Climbing Perch of India, and its smaller relatives the *Trichogasters*, are kept four or five days alive by the natives of Calcutta in earthen pots destitute of water, and from which daily requirements are supplied, the remaining fish appearing to be as lively as when first captured. The *Osphromenus olfax* is reputed to be grown and fattened in similar pots by the residents of Batavia, the water being occasionally changed.

I think the foregoing instances are sufficient to raise the probability that there may be two forms of respiration amongst Asiatic freshwater fishes:—*first*, by employing at the gills the air contained in the water; *secondly*, by respiring air direct.

When my attention, in 1866, was first attracted to these phenomena, I was not aware that Mr. Boake had published the previous year, in the Journal of the Ceylon Branch of the Royal Asiatic Society, a paper full of interesting facts proving that certain fish in that island were, as he termed them, "air-breathers," as distinguished from the usual "water-breathers." He records how he found men and cattle moving about over rank grass growing in a certain locality, beneath which were fish inhabiting a fluid muddy substance as thick as pea-soup. These fish rose to the surface, their presence being detected by the emission of bubbles of air. They, in fact, acted as Seals and other marine Carnivora do in the Arctic regions when rising to breathe air at their blow-holes in the ice. The sod covering the Ceylon tank or muddy spot, as recorded by Mr. Boake, acted as efficiently to prevent the fish obtaining atmospheric air as does the unbroken

ice in the Polar regions. Both adopt the same plan; both have blow-holes; and it is at these places that man watches for and captures his prey.

The generality of fish, as is well known, undoubtedly respire air which is in solution in the water in which they reside, and find such sufficient for respiratory purposes, except under some peculiar circumstances, when they obtain it direct from the atmosphere.

On June 27th, last year, I accompanied Dr. Dobson to the Dublin Zoological Gardens. In one of the tanks at the aquarium were three common eels (*Anguilla vulgaris*), whose usual mode of respiration appeared to be as follows:—Opening their mouths, they took in the amount of water they required, transmitting it backwards through the gill-opening. In this course it passed the branchiæ, and thus the blood was oxygenated. One, however, appeared indisposed; for instead of taking in water like his companions, he raised his head to the surface, and each time he did so he opened his mouth and a current of bubbles was sent backwards through his gill-openings. Here were three specimens of the same species placed in identical situations, whilst they showed different modes of oxygenating their blood; the air contained in the water sufficed for two, whereas the third was obtaining it direct from the atmosphere.

In 1871, at Calcutta, I procured some living specimens of eels (*Ophichthys boro*). The gills of this fish are contained in large cavities, one on either side of the head, those on one side being divided from those on the other by an impervious septum. On watching its movements, it was seen to distend this receptacle* with air taken in at the mouth, or, if in water, to live equally well by passing this fluid through the gill-cavity. On holding its small gill-opening firmly closed, it took in air by its mouth in distinct gasps: if its mouth were closed, it struggled until it was released, as, of course, without its use it could not respire. On exposing the gills by cutting away the gill-membranes, and then placing it in water, it could be seen to slowly move its branchiæ, even when in such a situation that it could not obtain atmospheric air direct. It appeared to be able to employ for respiration air dissolved in water or air inspired directly from the atmosphere.

We see, when the water gets foul or warm in the summer, or insufficient in quantity for the contained fish, they take in air

* In fishes having small external branchial openings the cavity containing the gills is usually large; and these fish, as a general rule, live some time after their removal from water.

direct, which is said by some naturalists to be ejected *per anum* after it has been used. Native fishermen assert that the midday is the best time to net tanks, as the fishes are nearer the surface.

In order to prove the correctness or the reverse of Indian freshwater fishes having two normal modes of respiration, I instituted a number of experiments, which I do not propose detailing in full (see 'Proc. Zool. Soc.' *l. c.*), but some of which I must advert to for the purpose of illustrating my views.

Before, however, I commence this, I think the following proposition will be admitted—*that if fish aerate their respiratory organs from air contained in the water in which they reside, there cannot normally be any necessity for their rising to the surface to take in atmospheric air direct.*

Of course, under certain abnormal conditions, all species rise to the surface, as I have already pointed out; but the following experiment will show that the freshwater fishes of India are divisible into two distinct classes as regards respiration.

I took a glass globe which I nearly filled with fresh water and into which I put a Barbel (*Barbus*) and a Walking fish (*Ophiocephalus*): the first used its gills freely, but did not come to the surface. The second moved its gills sluggishly, but every now and then ascended to the surface; and each time it did so, it appeared to blow out a bubble of air. These were normal conditions of respiration as invariably observed in these examples of the two classes under ordinary circumstances.

I then took a piece of net, which, by means of a ring of split rattan, could be pushed into the globe of water, thus dividing the interior as by a diaphragm. This I inserted about 2 inches below the level of the water, so that it became impossible for the contained fishes to rise to the surface and obtain atmospheric air.

The result in all instances was similar. The fishes which moved their gills rapidly and did not normally rise to the surface remained unaffected; those which normally rose to the surface became more and more sluggish, and died in a longer or shorter period, apparently in a ratio corresponding with whether they had been quiescent or excited, the quiescent ones living the longest.

Conclusive as the above results appeared to be, I tried another series of experiments. I stitched a bandage round the gill-openings of both these classes of fishes. Those which normally used their gills rapidly and did not rise to the surface soon died; those

which normally rose to the surface, apparently for the purpose of respiring atmospheric air direct, were unaffected.

If, as has been and still is maintained, these accessory organs or sacs are for the purpose of retaining water to moisten the gills* whilst these fishes are wandering on the land, how comes it that when placed in a situation where such a requirement is not needed (as in a globe of water under a net) they die? On the other hand, I have kept these fishes hours, have seen them kept alive days, with merely the addition of a sprinkling now and then of water. In this moist condition they are lively, and the earthen pot in which they are contained has numerous mucus-covered bubbles present and more being constantly formed by the respiration of these fishes.

From the foregoing I came to the conclusion:—*first*, that in the fishes which died when deprived of direct access to atmospheric air death was not occasioned by any deleterious properties either in the water or apparatus employed, but simply because they were unable to sufficiently decarbonize their blood on the air present solely in the water; *secondly*, that they were able to live in moisture (out of water) for lengthened periods; *lastly*, that the cavity or receptacle admitted to exist in such fishes (as are here termed amphibious) is not for the purpose of retaining water for moistening the gills, but that its walls have a highly vascular covering, and air is passed there for the purpose of respiration, whilst it seems probable that the air, having been so employed, is ejected by the mouth and not swallowed.

I had intended forming an artificial opening through the muscles of the back into the respiratory air-sac of the *Saccobranchus fossilis*; but injuries caused by its pectoral spine assume such a phlegmonous character that I desisted, after one of my native servants had nearly lost his arm from a wound inflicted by one of those fishes, which the fishermen had previously refused to handle.

However, in looking over a paper by Dr. Taylor ('Gleanings in Science,' 1830, p. 170), I found the following observations respecting this fish:—"If a quill, open at both ends, be introduced through an incision at the side of the spine into one of these canals (air-sacs), bubbles of air will arise from it"—thus showing that this cavity is for the reception of air, not of water. Likewise, amongst the Ophiocephalidæ, if they are held firmly under water, then turned over on their backs and the gills opened, bubbles of air arise.

* If the branchiæ become dry, respiration is precluded.

Thus far it is evident that we have fishes which breathe air, die if they cannot obtain direct access to it, and whose respiratory cavities are found to contain gaseous substances, not water—or proving my first proposition, that *there are fishes in Asia which normally respire atmospheric air direct.* It now becomes necessary to inquire what are these fishes? and how do they differ in their circulation from what obtains in ordinary fish?

The genera of fishes (excluding Clupeidæ) which exist in the fresh waters of India and possess respiratory organs having a lung-like function, and which are distinct from the gills, are as follows:—

Amongst the Acanthopterygians we have genera of the Labyrinthici, all of which possess a cavity above the upper portion of the first branchial arch, which contains an elaborate apparatus consisting of thin laminæ of bone covered by a vascular mucous membrane. Of these we have species of *Anabas*, *Polyacanthus*, *Osphromenus*, *Trichogaster*. The Ophiocephalidæ have likewise a cavity above and accessory to the true gill-cavity, and covered with an extremely vascular mucous membrane. Amongst the Siluridæ, all of which possess an air-vessel in the abdomen connected by a duct with the pharynx, we have in addition an accessory air-breathing apparatus. The genus *Clarias* has a dendritic accessory branchial apparatus attached to the convex surface of the second, third, and fourth branchial arches; and this is received into a recess behind the situation of the normal gill-cavity; it appears like sticks of red coral. From the dissections of M. Geoffroy in the Nile species it would appear that these arborescent-looking organizations are composed of a semitransparent substance, their external surface being densely covered by minute branches of the branchial artery; and here some at least of the blood appears to be aerated. Cuvier assigns to this organ the double function, of affording a surface for the oxygenation of blood, and as so many hearts for propelling it into the aorta. Mr. Boake (Journal Ceylon Branch Royal Asiatic Soc. 1865–66, p. 133) shows that this genus of fishes is one which takes in air direct. The genus *Saccobranchus* has an accessory respiratory sac to the gills, which extends backwards along either side of the neural spines amongst the dorsal muscles of the abdominal and part of the caudal regions.

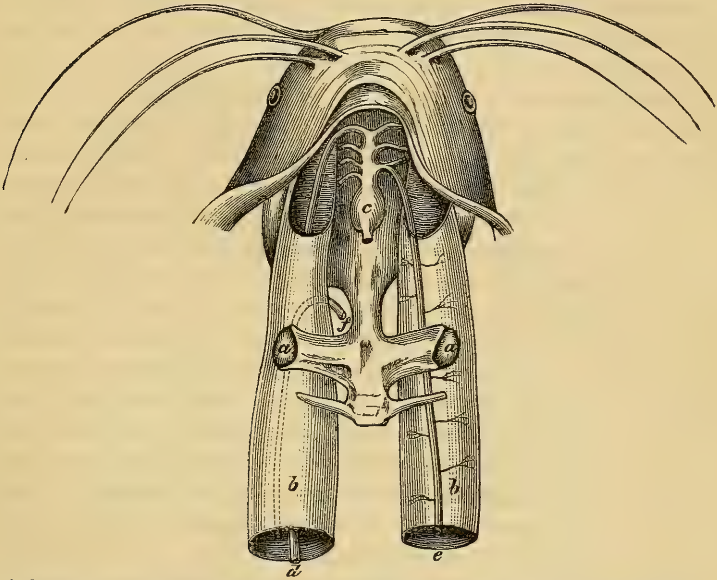
Amongst the eel-like forms of the family Symbranchidæ, we have the Cuchia eel (*Amphipnous cuchia*), which possesses three branchial arches having rudimentary laminæ and a respiratory air-sac, which communicates with the gill-cavity.

In every fish of the fresh waters of India that I have personally observed respiring atmospheric air direct, or of which I have been able to collect indisputable evidence that they do so, we find an accessory respiratory organ to the gills:—in *Clarias* an arborescent vascular one; amongst Ophiocephalidæ a somewhat simple cavity above the gill-opening also covered with a vascular membrane; in the Labyrinthici an elaborate one of thin bony laminæ. In *Amphipnous* we see that "of all the arches the second alone possesses laminæ for the purposes of breathing; and these consist merely of a few long fibrils attached to the middle of the arch and occupying but a very small extent of its surface; the third supports in the place of laminæ a thick and semitransparent tissue, which in large individuals of the species presents a fringed or denticulated appearance at its edge; whilst the third and fourth are bare, having only the membrane that fills up the space between the arches reflected over them. The principal organs of respiration are two small bladders, which the animal has the power of filling with air, immediately derived from the atmosphere. They are placed behind the head, one on each side of the neck, above the superior or vertebral extremities of the branchial arches, and are covered over by the common integuments, presenting externally, when distended with air, two protuberances of a round shape . . . . . They present, when separated from their surrounding attachments and inflated with air, thin, semitransparent, membranous parietes, resembling the posterior portions of the lungs of a serpent . . . . . Of the whole volume of blood contained in the branchial artery, one third passes through the gills and respiratory bladder, whilst the other two thirds are conveyed directly from the heart to the aorta without being exposed to the action of the air."—TAYLOR, *l. c.*

I asked Dr. Hubrecht to be so good as to dissect a *Saccobranchus* for the purpose of tracing out its circulation. This he did, remarking, however, that Hyrtl (Sitz. d. k. Akad. Wiss. Math. Cl. Bd. xi. Heft 2, 1853, p. 305) had already accomplished this, and that his present dissection went, as a whole, entirely to corroborate what Hyrtl had published. From the exceedingly developed *bulbus arteriosus* (*c*) of the heart spring the four pairs of branchial arteries. Of these the fourth pair on the left and the first pair on the right* are more developed than their neighbours;

* This distribution appears to be an exaggerated form of how the pseudobranchiæ are supplied with blood.

and after traversing their corresponding branchial arch, they take their way to the dorsal respiratory air-sacs (*b*), on the surface of which numerous lateral branches spring from the principal longitudinal vessel. This vessel at the respiratory sac is along the



A dissection showing the air-sacs and circulatory apparatus in *Saccobranchus*, altered after Hyrtl.

a a, air-bladder; *b b*, respiratory air-sacs; *c*, bulbus arteriosus; *d*, vessel of right side, from anterior branchial pair; *e*, vessel of left side, from fourth branchial pair; *f*, vena arteriosa, communicating with branchial vein of fourth pair of branchiæ.

dorsal surface (*d*) of the right side, and on the ventral surface (*e*) of the left; and each of them gives off a branch to the posterior wall of the branchial cavity, the mucous surface of which is provided with a network of respiratory capillaries.

The blood having passed through the capillaries of the respiratory air-sac, is collected into a *vena arteriosa* (*f*), which communicates with the branchial vein of the fourth pair of branchiæ, and the blood is driven, together with that returning from the other branchiæ, to the common aorta.

Some independent branches, going to muscles of the back &c., spring from the *vena arteriosa* of the respiratory air-sac even before its contents have entered into the general circulation by the more

regular way of the aorta, some smaller veins coming from the trunk likewise to enter into the capillary system of the respiratory air-sac.

The respiratory air-sacs are direct continuations of the mucous membrane of the branchial cavity. Two layers enter into the composition of their walls—an external fibrous, and an internal delicate one.

Here we see much the same process carried out as in the Cuchia eel—blood oxygenated at a respiratory sac, and, conjoined with that oxygenated at the lungs, returned purified direct to the aorta; whilst an air-bladder (*a*) with its pneumatic duct likewise exists.

Knowing this, we can now account in a most satisfactory manner for the experiments and their results. In these amphibious fishes the great proportion of the blood which is oxygenated is thus purified at the respiratory air-sac; this now arterialized blood, joined with the smaller portion which has been oxygenated at the gills, enters the aorta. In active life and continued muscular movement it is necessary that a large amount of blood should be decarbonized; in fact the use of the respiratory air-sacs is required, the access to atmospheric air a necessity. Failing access to atmospheric air, the gills come into play; and they are able to carry on a moderate amount of oxygenation, but insufficient for much muscular action or active exertion.

Now the problem arises, Where are amphibious fishes found? why should they exist?

The Labyrinthici are spread throughout Sind, India, Ceylon, Burma, Siam, the Malay archipelago to the Philippines, and China. Two genera are likewise found in Southern Africa. In fact they are distinctly tropical forms, and mostly found in low-lying localities but little removed from tidal reach, or in the deltas of large rivers.

The Ophiocephalidæ are distributed thoughout the plains of India, Ceylon, Burma, Siam, the Malay archipelago to the Philippines, and China: one species extends westward to Beloochistan and Afghanistan; and I have taken it at the Andamans. These fishes are very carnivorous; and I have seen them pursuing the little *Haplochili* up small streams where there would not be sufficient water to oxygenate their gills; but respiring atmospheric air, this necessity becomes avoided. The favourite resort of the Ophiocephalidæ is amongst the grass at the margin of a tank, where they can lie in such shallow water that their mouth is either

just out of, or immediately under, the surface. Here they respire with ease, and are ready to capture any incautious frog that passes that way.

It is the same with the amphibious Siluroids. It has appeared to me that they are mostly found in irrigated fields, ditches, and the like, that they push up these to deposit their ova, and are thus constantly running the risk of having the water-supply cut off. This possibility of respiring air permits amphibious fishes to ascend small streams and deposit their ova in situations where the young may be hatched and remain in safety until large enough to take care of themselves, but where their great enemies, especially carp, are unable to attack them.

We now arrive at the consideration of my fourth proposition —*that the respiratory sac is certainly not homologous with the swim-bladder of fishes, but is more probably with the respiratory sac of amphibious reptiles.*

Cuvier observed that "the gills are the lungs of animals absolutely aquatic." Geoffroy St.-Hilaire regarded the branchial arches of fishes as the modified tracheal rings of the air-breathing classes. If this view is correct, these respiratory sacs, which are merely formed by a continuation of the mucous membrane lining the branchial cavity, are a part and portion or an addition to the branchiæ.

Professor Owen denies the homology of branchial apparatus with the lungs, and tests his opinion by considering the homologies of the air- or swim-bladder in fishes. First pointing out that the totality of the organization of *Lepidosiren* is ichthyic, he contrasts it with the Ganoid *Polypterus.* The *Lepidosiren* has a cellular lung formed by the partition of the bladder into two elongated sacs, with a supply of venous blood from a true pulmonary artery, and also a pneumatic duct going to the ventral surface of the œsophagus. In the two forms compared, the arteries of the swim-bladders are derived from the returning dorsal portions of the branchial vascular arches before their union to form the aorta, venous in *Lepidosiren*, partially arterialized in *Polypterus.*

Without doubt this negative argument is good, and might be considered conclusive, were it not that we have in *Saccobranchus* a respiratory sac (*b, b*) and *also a swim-bladder* (*a*). This swim-bladder, although partially enclosed in bone, has its pneumatic duct leading into the alimentary canal. This duct, of which so much has been made as establishing a communication with the ventral

surface of the pharynx, is seen in the amphibious *Lepidosiren*; but it seems to have been overlooked that the respiratory sac of *Saccobranchus* is likewise connected with the commencement of the alimentary canal and at its dorsal surface.

The air-bladder, or swim-bladder, is found amongst the fresh-water fishes of India in two distinct forms—(1) enclosed in a bony case formed by a portion of the first or second vertebra or auditory ossicles, (2) free in the abdominal cavity. There are intermediate forms; and (3) it may even be absent. In the Physostomi, as in the Siluroids and Carps, whether enclosed in bone or free in the abdominal cavity, it possesses a duct opening into the alimentary canal. Much stress has also been laid upon the interior of this swim-bladder being occasionally found subdivided, as in the respiratory sacs of reptiles; but the same has been observed in the respiratory air-sac of the Cuchia eel.

The pneumatic duct, as already observed, has been looked upon as the homologue of the trachea, permitting in the embryo an extension of the mucous membrane lining the alimentary canal to the swim-bladder. There are some objections to this view. The pneumatic duct, it must be admitted, does open into the alimentary canal at a spot situated somewhere between the end of the stomach (as in the herring) and the pharynx. But in the majority of Teleostean fishes which possess swim-bladders, more especially in the marine forms (excluding Clupeidæ), there is no pneumatic duct and no connexion between the swim-bladder and alimentary canal; in many there is no swim-bladder at all, the same as in most fishes there is no respiratory sac.

I do not propose in this place to inquire into what is the homologue of the swim-bladder, as I hope to do so at some future date; but I will merely point out that in the carp, although it possesses a pneumatic duct leading from the swim-bladder into the alimentary canal, it has also a communication with the acoustic apparatus; in fact, such in many fishes is effected either by a tubular prolongation or by chains of ossicles, termed by Weber the malleus, incus, and stapes, in which Owen observed he had mistaken a relation of analogy for one of homology.

Lastly, I would observe that the artery to the swim-bladder carries arterial blood from the abdominal aorta, cœliac artery, or branchial vein, whereas that to the lungs or respiratory air-sacs conveys venous but returns arterial blood.

In the genera *Saccobranchus* and *Clarias* we find a swim-

bladder as described, with its pneumatic duct leading to the alimentary canal—and its supply of blood being arterial when received, venous as returned into the general circulation. But we have also the respiratory air-sacs, which are direct continuations of the mucous membrane of the branchial cavity, and consequently in the embryonic state were connected with the upper extremity of the alimentary canal. That this respiratory air-sac with a lung-like formation is, as a rule, absent in fishes, is no argument against this view; for the swim-bladder is likewise often absent. This respiratory air-sac, when existing, appears to be always in connexion with the alimentary canal, the swim-bladder only sometimes, whilst the latter has also communication with the acoustic apparatus. Lastly this respiratory air-sac receives venous and returns arterial blood into the general circulation.

The *Saccobranchus*, in short, is a true amphibious fish, with both a respiratory sac and swim-bladder, the former of which has an analogous function with, and is, I believe, the homologue of, the respiratory sac of amphibians; whereas its swim-bladder, which cannot also be the homologue of the same organ, both existing in the same species, I leave for future consideration.

Having thus briefly reviewed the amphibious fishes of India and the East, we arrive at the question of the migrations of Indian fishes. Before commencing this, a few explanatory remarks are necessary. Thus marine fish very frequently migrate into the fresh waters for breeding or predaceous purposes. Sometimes passing over high banks with a flood tide, their return to the sea is frustrated by the waters falling; and it not uncommonly happens that fish thus made prisoners of cannot reenter the sea until the succeeding year. Many doubtless die; some do not; in fact, Hyder in the last century introduced the *Chanos salmoneus* from the sea into a tank in Canara, and they are there to this day. On the other hand, did one ever hear of a freshwater fish retiring to the ocean to breed? one has been said to have been captured out at sea. I allude to the *Gobius giuris*. I do not question the fact; but I suppose the reason to have been as follows. During the monsoon-season great volumes of water are carried down the rivers, dry watercourses become impetuous torrents, rivers are so full that nothing withstands their current. I have seen hill-snakes washed down in Malabar, even so far as Cochin; and at one of these periods I obtained a bottle of fresh water taken some miles out at sea, but opposite the opening of the Cochin river.

Freshwater fishes, so far as I know, cannot live in the sea; it is entirely unsuited for them; and this is one reason for believing that as Indian freshwater fishes are found in Ceylon, the Andamans, and Nicobars, there must have been at one time a land connexion, so that a freshwater continuity was possible.

Limiting my remarks to the migrations of strictly freshwater fishes in India, I think there are two subjects for consideration:—

(1) Migrations as observed at monsoon-seasons.

(2) Fishes falling from the clouds.

The migrations of fishes at the commencement of monsoons are due to two causes—breeding-purposes, and a search for food. I do not propose entering upon the breeding of Indian freshwater fishes here, as the subject would inordinately increase the length of this paper; I will therefore merely remark that certain marine forms deposit their ova in the rivers of the plains, that many species from the plains ascend hill-rivers and choose side-streams for their offspring, whilst most of the amphibious forms pass up small watercourses and there deposit their ova. In short, the direct aerial respiration of certain amphibious fishes is a provision to enable those forms to migrate through moist grass and muddy channels. Numerous examples are given in Sir E. Tennent's 'Ceylon' and elsewhere of migrations of these fishes.

It is evident that as soon as the rains set in we find nature revivified in the East; and with the vegetation animal life wakens up. Insects and Invertebrates appear; food that is suitable for fish begins to abound. In tanks during the hot months the smaller forms of fish have served for the nourishment of the large ones; but as the bivalves, univalves, and frogs make their appearance the fish evidently begin to change their diet. Thus it is that at the commencement of the rains fish become very excited; apparently dissatisfied with the localities they inhabit, they restlessly seek a change. This may be owing to the same instinct which causes the migration of marine fishes to the fresh waters; or a change in the state of the waters augments their appetite, and with such arises the necessity of seeking a place where food more abounds.

The second form of migration of fishes, or their suddenly appearing where they have not been previously observed and could scarcely have existed, is one which deserves attention; and of this we have two forms—(1) falling from the clouds, (2) appearing in the plains or elsewhere after heavy rains.

That fishes have been observed falling from the clouds has been

shown on such conclusive evidence that a recapitulation of instances appears to be superfluous.

Fishes have been observed in the East to fall from the clouds in a fresh or in a decomposed condition. With reference to this, it has been said that, sucked up by waterspouts, they may be carried long distances. Last year, on October 5th, it was observed in 'Nature' that "a tornado of almost unexampled intensity and destructiveness swept over the Isle of Wight . . . and extended at least 16 miles to the N.E. of Cowes . . . A gentleman in a small yacht, which fortunately was out of the course of the tornado, suddenly heard sounds very much resembling the noise caused by the escape of steam when at its highest pressure; and at the same time the whole sky became clouded with articles of all forms and sizes, which were carried through the air to a height of about 300 feet and parallel with the shore . . . Turnips and other crops were literally dragged out of the ground." This instance shows on a small scale what exists in the East, how articles may be sucked up, how little pools of water with the contained fish may be taken up in a whirlwind; and should the heat be excessive, one can easily imagine how soon these masses of animal substance might decompose. Every one in India has observed miniature whirlwinds sucking up the dust in an hour-glass form, and with it pieces of straw &c. which come within its influence.

The various accounts of fishes falling from the clouds may be classified as follows:—*first*, those descending during violent storms of winds and rain; *secondly*, appearing when no storm occurred. Amongst the first of these classes they have been recorded as distributed over some considerable extent of country in a continuous straight line, not more than a span in breadth, or else as covering a moderate-sized spot.

Of the second form it has always seemed to me to be an open question whether such were not fishes appearing suddenly in moist places where they had not been previously observed, and in a manner which I now propose to enter into.

I have seen large fish suddenly appear after heavy rains in most unlikely places—in fact, where but recently the locality had been a dry open plain; and I have since seen them dug out of the ground. I place these two instances together, as one may have a considerable bearing on the other. During the dry months of the year it is certain that almost every piece of water is stocked with fish; and at these periods the minute forms play a most

important part in providing for the nourishment of the larger kinds.

All species, amphibious or not so, it is asserted, may be found torpid; and John Hunter's hypothesis is probably correct. He observes "that hibernation is apparently due to a suspension of the faculties of animals by nature during such seasons and in such situations that a supply of food is not obtainable." Fish sleep or æstivate during the hot months at a period when nature is generally torpid, reviving again with the monsoon-rains as animal life resuscitates.

In Orissa the following instance occurred of the exhumation of fishes from the earth.

I was fishing there in January 1869, in company with a very intelligent native, to whom I expressed a wish to see fish exhumed from the mud of tanks. He remarked that those which I have termed amphibious, and also the spined eels, or Rhynchobdellidæ invariably retire into the mud of tanks as the water dries up; but he denied that carp ever did.

He suggested that we should at once make a trial at a neighbouring tank, which was about an acre in extent and had not more than four inches depth of water in its centre, whilst its circumference was sufficiently hardened to walk upon. The soil was a thick, consistent, bluish clay, and no excavation was made within thirty paces of the water.

Within five minutes the coolies extracted, from at least 2 feet below the mud, two *Ophiocephalus punctatus* and three *Rhynchobdella aculeata*, all of which were lively and not in the least torpid.

There is a specimen of *Amphipnous cuchia*, or the amphibious eel, in the Calcutta Museum, 13 inches long, presented by S. E. Peal, Esq., with the following label:—"This fish was hoed out of stiff blue clay as I was standing overlooking men at work making a bund, June 24th, 1865. No water had been seen near for some time"*.

We could easily suppose that what occurs in the *Lepidosiren* may likewise take place in these amphibious fishes. *Lepidosiren* are found inactive during the hot dry months, when their pulmonary air-bladders are employed for respiration; during this time of the year they burrow in the mud, which becomes dried above, them; but they maintain a small communicating aperture with the outer world, "and coiling themselves up in their cool chamber clothe themselves by a layer of thick mucous secretion, and await

* The remainder of the label illegible.

in a torpid state the return of the rains." Again in water, they swim about, use their branchiæ; and with an augmented arterial circulation their activity returns, appetite increases, and propagation commences.

Whether the Indian amphibious fishes likewise maintain an outlet to the atmosphere, I have not been able to ascertain; but that in some conditions eels do so is indisputable. Yarrell observes, respecting eels burying themselves, that the people of Somersetshire know how to find the holes in the banks of the rivers in which eels are laid up, by the hoar-frost not lying over them as it does elsewhere, and dig them out in heaps*.

Note on a new Example of the Phyllodocidæ (*Anaitis rosea*). By W. C. M'Intosh, M.D., F.R.S.E., F.L.S.

[Read February 15, 1877.]

In the Catalogue of the Annelida in the British Museum the precise habitats of the Phyllodocidæ are very slightly alluded to. Thus, in regard to the common, though very beautiful, *Phyllodoce maculata*, Johnst., "Berwick Bay" is all the information afforded. At St. Andrews and other parts this species (which corresponds in colour and some other respects with the *P. citrina* of Malmgren) is very often found at the extreme margin of low water, several inches in the fine sand; and last autumn a single example of the new *Anaitis* occurred with it at the former locality.

The family Phyllodocidæ is at present a somewhat difficult one to study, because the bodies of the animals are both soft and friable, and lose many of their characters soon after preservation in spirit. Hence, in adopting Dr. Malmgren's generic title *Anaitis*, I concur with M. Claparède in doing so simply to avoid complication in synonymy.

The genus *Anaitis* is characterized by the fact that while the first three pairs of tentacular cirri are borne by the buccal segment, the fourth pair occur on the succeeding one; but much greater precision is yet required in this group.

Anaitis rosea is a small species, measuring about an inch and a half; but the tail is absent in the specimen. The head is pale ante-

* Although I have not personally seen any Cyprinidæ exhumed out of dried-up mud, still that such does occur in the East appears to be proved by sufficiently good authority. In fact, in Europe carps bury themselves in the mud, and pass months without eating, assembled in great numbers side by side.

riorly, with four pale terminal tentacles. In front of each eye is a bright rose-red band slanting downward and backward, and then turning round to join the larger rose-red area behind. Moreover a pinkish band from the centre of the snout joins the latter behind the eyes, which are thus encircled by a pale area. A broad mass of rose-red occurs behind the eyes, the central part being pale, while the lateral divisions assume a somewhat triangular outline, as seen from the dorsum. The same rose-red hue tints the bases of the tentacular cirri and passes some distance along their columns. An ochre-yellow band proceeds from the foregoing rose-red region backward along the median line of the dorsum to the tip of the tail. Throughout the first three segments it is flecked with reddish grains, but thereafter the band is bright yellow. Each lateral region of the body is minutely flecked with red, especially the anterior third; and, further, the pigment has a tendency to be arranged in transverse bars or streaks. The general tone of the rest of the body and lamellæ is pale buff. Besides the latter hue on the ventral surface, a rose-red band occurs from the line of the first tentacular cirrus to that of the first foot; so that when the animal rests on the side of the glass, it very closely resembles the abundant Nemertean *Amphiporus lactifloreus*, Johnst., with its reddish ganglia.

There is nothing peculiar in the shape of the head, except that it is hardly differentiated in the living animal from the succeeding segments, the whole presenting a somewhat elongated appearance, while the tip of the snout is blunt. The eyes are circular and comparatively small. The proboscis is withdrawn in the specimen.

The body is somewhat broad in comparison with its length. The superior lamellæ are lanceolate, and are borne out from the body on prominent pedicels. The bristle-bearing process is emarginate; and the bristles have rather slender shafts, with the usual enlargement at the distal end, which is spinulose along the terminal curves. The process at the tip is elongate and finely serrated; and the striæ on its blade slope from the point and edge downward and backward. The ventral lamellæ are also lanceolate, but much more acutely pointed, and project beyond the tip of the bristle-bearing processes.

The characters of the species are well defined, the small size of the eyes at first sight distinguishing it from the majority of its allies described by Malmgren and Claparède

Observations on the Habits of Ants, Bees, and Wasps.—Part IV.

By Sir JOHN LUBBOCK, Bart., M.P., F.R.S., F.L.S., D.C.L., Vice-Chancellor of the University of London.

[Read February 1, 1877.]

(PLATE XVII.)

ANTS.

IN my last paper on this subject (Journ. Linn. Soc., Zool. vol. xii. p. 445) I recorded some experiments showing the singular reluctance of Ants to let themselves drop even for a very short distance, and their want of ingenuity in bridging over chasms. Since then I have varied the experiments in the following manner.

Want of ingenuity in crossing Chasms.

I filled a saucer (woodcut, fig. 1, S) with water and put in it a block of wood (W), on the top of which I fastened a projecting wooden rod (B), on the end of which I placed a shallow glass cell (A P) containing several hundred larvæ. From this cell I allowed a slip of paper to hang down to within $\frac{3}{10}$ of an inch of the upper surface of the artificial nest (N). At one side I put another block of wood (C) with a lateral projection (D) which hung over the cell containing the larvæ. I then made a connexion between D and A, so that ants could ascend C, and, passing over D, descend upon the larvæ. I then put some specimens of *Lasius niger* to the larvæ, and soon a large number of ants were engaged in carrying off the larvæ. When this had continued for about three hours, I raised D $\frac{3}{10}$ of an inch above A. The ants kept on coming and tried hard to reach down from D to A, which was only just out of their reach. Two or three, in leaning over, lost their foothold and dropped into the larvæ; but this was obviously an accident; and after a while they all gave up their efforts and went away, losing their prize, in spite of most earnest efforts, because it did not occur to them to drop $\frac{3}{10}$ of an inch.

Fig. 1.

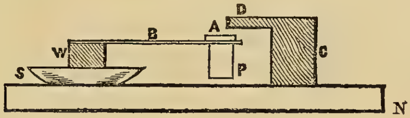


Diagram to illustrate experiments described in text.

At the moment when the separation was made there were fifteen ants on the larvæ. These could, of course, have returned if one had stood still and allowed the others to get on its back. This, however, did not occur to them; nor did they think of letting themselves drop from the bottom of the paper on to the nest. Two or three, indeed, fell down, I have no doubt, by accident; but the remainder wandered about, until at length most of them got into the water. After a time the others abandoned altogether as hopeless the attempt to get at the larvæ.

I waited about six hours, and then again placed the glass (A) containing the larvæ so as to touch the piece of wood (D), and again put some ants to the larvæ. Soon a regular string of ants was established; when I again raised the wood (D) $\frac{3}{10}$ of an inch above the glass (A), exactly the same result occurred. The ants bent over and made every effort to reach the larvæ, but did not drop themselves down, and after a while again abandoned all hope of getting the larvæ.

Experiments testing Intelligence.

In order to test their intelligence, it seemed to me that there was no better way than to ascertain some object which they would clearly desire, and then to interpose some obstacle which a little ingenuity would enable them to overcome. Following up, then, the preceding observations, I placed some larvæ in a cup which I put on a slip of glass surrounded by water, but accessible to the ants by one pathway in which was a bridge consisting of a strip of paper $\frac{2}{3}$ inch long and $\frac{1}{3}$ inch wide. Having then put a *Formica nigra* from one of my nests to these larvæ, she began carrying them off, and by degrees a number of friends came to help her. I then, when about twenty-five ants were so engaged, moved the little paper bridge slightly, so as to leave a chasm, just so wide that the ants could not reach across. They came and tried hard to do so; but it did not occur to them to push the paper bridge, though the distance was only about $\frac{1}{3}$ inch, and they might easily have done so. After trying for about a quarter of an hour, they gave up the attempt and returned home. This I repeated several times.

Then, thinking that paper was a substance to which they were not accustomed, I tried the same with a bit of straw 1 inch long and $\frac{1}{8}$ inch wide. The result was the same. I repeated this twice.

One day (Oct. 27th, 1876) I put some provisions in a shallow box with a glass top and a single hole on one side; I then put some specimens of *Lasius niger* to the food, and soon a stream of ants was at work busily carrying supplies off to the nest. When they had got to know the way thoroughly, and from thirty to forty were so occupied, I poured some fine mould in front of the hole so as to cover it up to a depth of about ½ an inch. I then took out the ants which were actually in the box. As soon as the ants had recovered from the shock of this unexpected proceeding on my part, they began to run all round and about the box, looking for some other place of entrance. Finding none, however, they began digging down into the earth just over the hole, carrying off the grains of earth one by one and depositing them without any order all round at a distance of from ½ to 6 inches, until they had excavated down to the doorway, when they again began carrying off the food as before.

This experiment I repeated on the following days three or four times, always with the same result.

I also tried the same experiment with another species, viz. *L. flavus*, and with the same result.

As to power of Communication.

In my previous paper I have recorded various experiments made with the view of ascertaining whether, when ants have found a store of food, they are able to describe the route to their companions. The following also seems to me instructive. I put an ant (*L. niger*) to some larvæ as usual, and when she knew her way, I allowed her to go home on her own legs; but as soon as she emerged from the nest, if she had any friends with her, I took her up and carried her to the larvæ. Under these circumstances very few ants indeed found their way to them. Thus, June 22, at 5.30, an ant which had been previously under observation was put to some larvæ. She took one and returned as usual to the nest. At 5.34 she came out with no less than 10 friends, and was then transferred to the larvæ. The others wandered about a little, but by degrees returned to the nest, not one of them finding their way to the larvæ. The single one above referred to picked up a larva, returned, and again came out of the nest at 5.39 with eight friends, when exactly the same thing happened. She again came out with companions at the undermentioned times:—

Hour.	Number of friends.	Hour.	Number of friends.
5.44	4	6.44	—
5.47	4	6.46	3
5.49	—	6.49	2
5.52	—	6.56	—
5.54	5	6.59	—
5.57	2	7. 2	2
5.59	2	7. 4	—
6. 1	5	7. 6	3
6. 4	1	7. 8	3
6. 7	—	7.10	5
6.11	3	7.13	—
6.14	4	7.17	3
6.17	6	7.19	7
6.20	—	7.21	5
6.23	5	7.24	—
6.25	6	7.26	3
6.29	8	7.29	1
6.32	2	7.31	2
6.35	—	7.35	—
6.42	4		

Thus during these two hours more than 120 ants came out of the nest in company with the one under observation. She knew her way perfectly; and it is clear that if they had been left alone, all these ants would have accompanied her to the store of larvæ. Three of them were accidentally allowed to do so; but of the remainder, only five found their way to the larvæ; all the others, after wandering about a while, returned hopelessly to the nest.

One of the ants which I employed in my experiments was under observation several days. I was, however, away from home most of the day, and when I left in the morning and went to bed at night I put her in a bottle; but the moment she was let out she began to work again. On one occasion I was away for a week, and on my return I let her out of the bottle, placing her on a little heap of larvæ about 3 feet from the nest. Under these circumstances I certainly did not expect her to return. However, though she had thus been six days in confinement, the brave little creature immediately picked up a larva, carried it off to the nest, and, after half an hour's rest, returned for another.

Individual Influence or Character.

Another point of considerable interest is the difference in individual character or influence which seems to be indicated by some of the experiments.

For instance, on the 21st of June, at 6 minutes past noon, a worker of *F. nigra* was put to some larvæ; she carried off one as usual and returned as follows, viz. at

12. 6	12.19	12.30	12.47
12. 8	12.21	12.33	12.51
12.10	12.23	12.36	
12.15	12.26	12.40	
12.17	12.28	12.44	

During this time only two other ants came to the larvæ. We then imprisoned the ant and put another to the same larvæ at 2.56. This ant already knew her way well, and she returned as follows, viz.:—

2.58	3.11	3.25	3.52
3. 1	3.13	3.27	3.57
3. 4	3.15	3.30	
3. 6	3.20	3.34	
3. 9	3.22	3.36	

During this time no other ant came. We then imprisoned her again, and put a third ant to the same larvæ. She returned at

4.20	4.30	4.46	5. 6
4.23	4.36	4.56	5.10
4.26	4.40	5. 0	
4.28	4.42	5. 2	

when we left off watching her. Between 4.20 and 4.40 this ant brought 10 friends with her; but it is curious that from 4.40 to the end of the observation no more came. I have often observed that when an ant first begins to work, she brings many more friends than afterwards.

Intelligence and Affection.

As evidence both of their intelligence and of their affection for their friends, it has been said by various observers that when ants have been accidentally buried they have been very soon dug out and rescued by their companions. Without for one moment doubting the facts as stated, we must remember the habit which

ants have of burrowing in loose fresh soil, and especially their practice of digging out fresh galleries when their nests are disturbed.

It seemed to me, however, that it would not be difficult to test whether the excavations made by ants under the circumstances were the result of this general habit, or really due to a desire to extricate their friends.

With this view I tried the following experiments:—

(1) I placed (Aug. 20) some honey near a nest of *Lasius niger* on a glass surrounded with water, and so arranged that in reaching it the ants passed over another glass covered with a layer of sifted earth, about one third of an inch in thickness. I then put some ants to the honey, and by degrees a considerable number collected round it. Then at 1.30 P.M. I buried an ant from the same nest under the earth, and left her there till 5 P.M., when I uncovered her. She was none the worse, but during the whole time not one of her friends had taken the least notice of her.

(2) Sept. 1. I arranged some honey again in the same way. At 5 P.M. about 50 ants were at the honey, and a considerable number passing to and fro. I then buried an ant as before, taking of course one from the same nest. At 7 P.M. the number of ants at the honey had nearly doubled. At 10 P.M. they were still more numerous, and had carried off about two thirds of the honey. At 7 A.M. the next morning the honey was all gone, two or three were still wandering about, but no notice had been taken of the prisoner, whom I then let out. In this case I allowed the honey to be finished, because I thought it might perhaps be alleged that the excitement produced by such a treasure distracted their attention, or even (on the principle of doing the greatest good to the greatest number) that they were intelligently wise in securing a treasure of food before they rescued their comrade, who, though in confinement, was neither in pain nor danger. So far as the above ants, however, are concerned, this cannot, I think, be urged.

(3) On the 8th Sept. I repeated the experiment, burying some ants at 4 P.M. Up to 6.3 no attempt had been made to release them. I let them out and buried some more. The next morning, at 7 A.M., the honey was all gone, some ants were still wandering about, but no notice had been taken of the captives, whom I then liberated.

(4) I then (Aug. 21) made exactly the same experiment with *Myrmica ruginodis,* as representing the other great family of

ants. At 2.30 I buried one as before under about $\frac{1}{4}$ of an inch of fine earth. A great many of her friends were passing continually over her head, but not one of them took any notice of her till 7 P.M., when I let her out.

(5) About a month later, on Sept. 10, I again tried the same experiment, imprisoning some at 10.15 A.M. Up to 4.30 they had not been released. I then let them out, and buried some more. The next morning the honey was all consumed, but some of the ants were still searching about. The prisoners, however, were still in durance.

But even if their friends who are in difficulty are actually in sight, it by no means follows that their companions will assist them.

Of this I could give almost any number of cases. Thus on one occasion several specimens of *Formica fusca* belonging to one of my nests were feeding on some honey spread on a slip of glass (May 22). One of them had got thoroughly entangled in it. I took her and put her down just in front of another specimen belonging to the same nest, and close by placed a drop of honey. The ant devoted herself to the honey and entirely neglected her friend, whom she left to perish.

Again, some specimens of *Cremastogaster scutellaris* were feeding quietly (May 22) on some honey spread on a slip of glass, and one of them had got thoroughly mixed in it. I took her out and put her on the glass close by. She could not disentangle herself; not one of her friends took the least notice of her, and eventually she died. I then chloroformed one and put her on the board among her friends. Several touched her, but from 12 to 2.30 P.M. none took any particular notice of her*.

I thought, however, that it would be desirable to make some systematic observations on the subject. The results were as follows.

Sept. 10, at 6 P.M., a number of *Lasius flavus* from one of my captive nests were out feeding on some honey. I chloroformed four of them and also four from a nest in the park, at some distance from the place where the first had been originally procured, and put them close to the honey. Up to 8.20 the ants had taken no notice of their insensible fellow creatures. At 9.20 I found that

* Dead ants, I may add, are always brought out of the nest, and I have more than once found a little heap on one spot, giving it almost the appearance of a burial-ground.

four friends were still lying as before, while the four strangers had been removed. Two of them I found had been thrown over the edge of the board on which the honey was placed. The other two I could not see.

Again, on the 14th Sept., at 8.40, I put in the same way four friends marked white, and four strangers marked red, close to where my *L. flavus* were out feeding on honey placed on a slip of glass over water. For some hours they took no notice of them. At length one took a friend, and after carrying her about some time, at 12.40, dropped her into the water. Some time after another took up a stranger and carried her into the nest at 2.35. A second stranger was similarly carried into the nest at 2.55, a third at 3.45, while the fourth was thrown over the edge of the board at 4.20. Shortly after this two of the strangers were brought out of the nest again and thrown away. A second friend was thrown away, like the first, at 4.58, the third at 5.17, and the fourth at 5.46. I could not ascertain what happened to the last stranger, but have little doubt that she was brought out of the nest and thrown away like the rest.

On the following day at 6.45 I tried the same experiment again, only marking the friends red and the strangers white. At 7 one of the strangers was carried off and dropped over the edge of the glass into the water, and at 8 a second. At 8.45 a friend was taken up and, after being carried about some time, was thrown into the moat. At 9.45 a friend was picked up and carried into the nest, but brought out again and thrown away about 3 in the afternoon. The other four remained where they were placed until 8 P.M., and though the other ants often came up and examined them, they did not carry them off.

Sept. 29. Again placed nine chloroformed ants, five friends and four strangers, close to where a number were feeding. There was a continual stream of ants to the honey, ten or fifteen being generally there at once.

A stranger	was	picked up at	10.20	and dropped at	10.32
,,	,,	,,	10.22	,,	10.35
A friend	,,	,,	11.22	,,	11.42
A stranger	,,	,,	11.35	,,	11.50
,,	,,	,,	11.41	,,	11.45

Shortly after the others were picked up and carried away to the edge of the board, where they were dropped, but none were taken into the nest.

Oct. 2. Again at 10 A.M. placed ten chloroformed ants, five friends and five strangers, close to where some were feeding. They were picked up and carried off as before in the following order:—

At 11. 5 a stranger	was picked up	and dropped at	11.15
11.12 a friend	„	„	11.50
11.25 a stranger	„	„	11.36
12. 7 „	„	„	12.45
12.10 a friend	„	„	12.16
1.10 a stranger	„	„	2. 6
1.42 a friend	„	„	1.46
1.52 „	„	„	1.56
2. 6 „	„	„	3.10

Only one of them, and that one a stranger, was carried into the nest at 12.45, but brought out again at 1.10.

Oct. 6. At 9 A.M. again tried the same experiment with four strangers and five friends.

At 9.25 a friend	was picked up	and dropped at	9.31
9.32 „	„	„	9.38
9.35 a stranger	„	„	9.45
9.45 a friend	„	„	9.52
10. 8 a stranger	„	„	10.17
10.17 a friend	„	„	10.20
10.22 a stranger	„	„	10.25
10.28 „	„	„	10.40
10.25 a friend	„	„	10.31

None of them were carried into the nest.

These experiments seem to prove that under such circumstances ants, at least those belonging to this species, do not carry their friends (when thus rendered insensible) off into a place of safety.

It may, however, be said that in this experiment, the ants being to all intents and purposes dead, we could not expect that any difference would be made between friends and strangers. I therefore repeated the same experiment, only instead of chloroforming the ants I intoxicated them. This experiment is more difficult, as it is not in all cases easy to hit off the requisite degree of intoxication. The numbers therefore of friends and strangers are not quite the same, because in some cases the ants recovered too quickly and had to be removed. In such cases I have latterly replaced the ant so removed by another, so as to keep the number of friends and strangers about equal. I must make more obser-

vations; but so far as they have gone they are as follows. The sober ants seemed somewhat puzzled at finding their intoxicated fellow creatures in such a condition, took them up, and carried them about for a time in a somewhat aimless manner.

Nov. 20. I experimented with six friends and six strangers, beginning at 11.

At 11.30 a friend was carried to the nest.

11.50 a stranger was dropped into the water.

12.30 " " "

12.31 a friend " "

1.10 a stranger " "

1.18 " " "

1.27 " " "

1.30 a friend (partly recovered) was taken to the nest.

2.30 " was taken up and carried about till 2.55; she was then taken to the nest, but at the door the bearer met two other ants, which seized the intoxicated one, carried her off, and eventually dropped her into the water.

At 3.35 a friend was carried to the nest.

Out of these 12, 5 strangers and 2 friends were dropped into the water; no stranger but 3 friends were taken to the nest. None of the friends were brought out of the nest again.

Nov. 22. Experimented in the same way on four friends and four strangers, beginning at 12.

At 12.16 a stranger was taken and dropped into the water.

12.21 " " "

12.23 " " "

12.40 " " "

I then put 4 more strangers.

3.10 a stranger was taken and dropped as before.

3.30 " " "

3.35 " " "

3.44 a friend (partly recovered) was taken back to the nest.

4.10 a stranger was taken and dropped into the water.

4.13 a friend (partly recovered) was taken back to the nest.

In this case 8 strangers were dropped into the water, and none were taken to the nest; 2 friends, on the contrary, were taken to the nest, and none were dropped into the water.

Dec. 1. Experimented with five friends and five strangers, beginning at 2.15.

At 2.30 a stranger was dropped into the water.

3. 2 " " "

At 3.20 a friend was taken into the nest.
3.35 a stranger " "
3.52 " " "
4. 5 I put out four more friends and as many strangers.
4.45 a stranger was dropped into the water.
5.10 " taken into the nest.
5.24 " " "
5.55 a friend was thrown into the water.
6. 4 a stranger " "
6. 4 " " "
6. 8 a friend was taken into the nest.
6.20 " " "
6.23 " " "
6.30 a stranger was dropped into the water.
6.50 a friend " " "
8. 5 a friend was taken into the nest.

In this case 2 friends were thrown into the water and 7 taken into the nest; while 6 strangers were thrown into the water and 3 were taken into the nest (*all of these, however, were afterwards brought out again and thrown away*).

Dec. 8. Experimented with six friends and six strangers, beginning at 11.30.

At 11.30 a friend was carried to nest.
11.47 " "
11.50 " "
11.52 " "
11.56 a friend was dropped into water.
11.58 a stranger " "
11.58 " " "
12 a stranger was carried to nest.
12. 2 " " "
12. 3 " " "

I then put four more of each, replacing her by another as each was carried off.

At 12.42 a friend to water.
12.58 a stranger to water.
1 a friend to nest.
1 " "
1 " "
1.58 " "
1.59 " "
2.30 a stranger to water.
2.30 " "
2.35 a stranger to nest.

At 2.42 a stranger to water.
2.48 " "
2.51 " "
2.52 " "
2.55 a friend to nest.
2.55 a stranger to water.
2.55 " "
3. 2 a friend to water.
3. 6 a stranger to water.
3.12 a friend to water.

At 3.15 a friend to water.
3.16 a friend to nest.
3.22 a stranger to water.
3.25 " "

At 3.25 a friend to nest.
3.35 a stranger to water.
3.50 a friend to nest.
3.50 " "

All these ants appeared quite insensible; 16 friends were then taken to the nest and 5 to the water, while of the strangers only 3 were taken to the nest, while 15 were thrown into the water. Moreover, as in the preceding observation, even the three strangers which were at first taken to the nest were soon brought out again and thrown away; while this was not the case with any of the friends as far as we could ascertain, though we searched diligently for them also. In this case also all the intoxicated ants were motionless and apparently insensible.

Jan. 15. Repeated the same experiment, beginning at 12.20. Up to 7 P.M. not one of the intoxicated ants had been moved. At 8.20 we found a stranger in the water, at 9.30 another, and at the following morning a third. The others were untouched.

Jan. 17. Repeated the same experiment, beginning at 11.30.

At 12 a friend was carried to the nest.
12.20 a stranger was carried to the water.
12.34 a friend was carried to the nest.
12.40 a stranger was carried to the water.
12.45 a friend was carried to the nest.
1 a stranger " "
1 " " " water.
(Stopped observing till 2.)
2.30 a stranger was carried to the water.
2.30 " " nest.
4.10 " " "
4.30 a friend " "
6.20 a stranger was carried to the water.
6.35 " " "

Thus, then, the general results were that the ants removed thirty-eight friends and forty strangers. Of the friends, twenty-seven were carried into the nest and seven were thrown into the water. Of the strangers, on the contrary, thirty were thrown into the water; only nine were taken into the nest, and seven of these were shortly afterwards brought out again and thrown away. Indeed I fully believe that the other two were treated in the same manner, though we could not satisfy ourselves of the fact. But it was only by very close observation that the seven were detected, and the other two may well have escaped observation.

Tabular View.—Experiments on Ants under Chloroform and Intoxicated.

Chloroformed Ants.

	Friends.			Strangers.		
	To nest.	To water.	Unremoved.	To nest.	To water.	Unremoved.
Sept. 10...	......	...	4	......	4	
„ 14...	......	4	...	2 and brought out again.	2	
„ 15...	1 and brought out again.	1	...	......	2	2
„ 29...	......	5	...	......	4	
Oct. 2...	......	5	...	1 and brought out again.	4	
„ 6...	......	5	...	......	4	
	1	20	4	3	20	2

Intoxicated Ants.

	Friends.			Strangers.		
	To nest.	To water.	Unremoved.	To nest.	To water.	Unremoved.
Nov. 20...	3	2	...	......	5	1
„ 22...	2	...	2	......	8	

In these cases some of the Ants had partly recovered; in the following they were quite insensible.

	Friends.			Strangers.		
	To nest.	To water.	Unremoved.	To nest.	To water.	Unremoved.
Dec. 1...	7 none brought out again.	2	...	3 all these brought out again.	6	
„ 8...	16 none brought out again.	5	...	3 all these brought out again.	15	
Jan. 15...	...	...	4	......	3	1
„ 17...	4 none brought out again.	...	...	3 one brought out again.	6	
	27	7	4	9	30	1

Recollection of Friends.

In my previous paper* I recorded some facts tending to show not only that ants belonging to the same nest know one another, but also that they recollect one another after being separated for some months.

This was made evident by separating a colony into halves, registered as Nests No. 4 and 5, and then from time to time introducing an ant from one division into the other. As the nests under observation consisted of a thin stratum of earth between two glass plates, I was able to see exactly how the ant thus introduced behaved herself, and how she was treated by the others.

One of the colonies thus separated belonged to *Formica fusca*, and was divided on the 4th Aug., 1875. The observations made in the same year have been already recorded. On the 15th March following, I put in a stranger and one of the old companions from the other half of the nest at 7 A.M., and watched them longer than those previously experimented on. The stranger was very soon attacked; the friend seemed quite at home.

4th June. 8 A.M. Put into the nest a stranger and an old friend. The stranger was at once attacked, and dragged about by one of her antennæ. 9 A.M. The stranger was being attacked; the friend, though not attacked, kept rather away from the other ants. 10.30 A.M. The stranger was attacked, not the friend. 12.30 P.M. do., 1 P.M. do., 1.30 P.M. do., 2 P.M. do., 2.30 P.M. do. 4 P.M. do., 4.30 P.M. do. 5 P.M. The stranger was dead.

5th June. Put in a stranger and a friend at 9.30. At 10 the stranger was being attacked, not the friend. 10 A.M. do., 10.30 A.M. do.

At 11 I put in another stranger and another old friend, when nearly the same thing was repeated. At 11.30 A.M. the stranger was being dragged about by an antenna; the friend was not attacked. 12. The stranger was by herself in a corner of the nest. The friend was almost cleaned from the paint by which she was marked. I therefore put in another friend. At 2 the stranger was being dragged about by an antenna, the friend was being cleaned. 2.30 do., 3 do. At 3.30 the friend was almost clean; the stranger is being dragged about. 6 do.

10th June. Repeated the same observation at 10 A.M., but transposed the colours by which they were distinguished, so that

* See vol. xii. p. 494, lines 17 and 18 from the top, and under the head of Nov. 7, I unfortunately transposed the words "former" and "latter."

there might be no question whether perhaps the difference of treatment was due to the difference of colouring. At 11 A.M. the friend was all right, the stranger was being dragged about by an antenna. 11.30 A.M. the friend all right, the stranger being dragged about by one leg. 12 do. 12.30 P.M. the friend all right, the stranger being dragged about by an antenna. 1 P.M. do., 2 P.M. do., 3 P.M. do.

3rd July. Put in a friend and a stranger at 11 A.M. At 11.30 A.M. the stranger was being dragged about, the friend was being cleaned. 12 do. 12.30 A.M. both were now being attacked. 1 do.

This seems to show that some, at least, of the ants have forgotten their old friends.

16th July. Put in two friends at 7.45 A.M. At 8 A.M. each was being dragged about by an antenna. 8.30 A.M. one was being dragged about by both antennæ, the other by both antennæ and one leg. 10 A.M. both were still attacked, but it is curious that at the same time others were cleaning off the paint. 12.30, both still attacked.

17th July. Put in a friend at 8.15 A.M. At 8.30 they were cleaning her. At 9 A.M. she was almost clean. 9.30 she seemed quite at home, and had only one spot of paint on her. 10.20 do.

20th July. Put in a friend and stranger at 9 A.M. At 9.30 A.M. the friend seemed all right; the stranger was in a corner by herself. At 10 A.M. the friend was being cleaned; the stranger had come out of her corner and was being fiercely attacked. At 11 A.M. the friend seemed quite at home and was almost cleaned; the stranger was being dragged about, but was almost cleaned. At 12 the same thing was going on, and also at 12.30. At 1.30 the stranger was still being pulled about; but what struck me as remarkable, the friend also had hold of one of the ants by an antenna. At 2 P.M. the friend was by herself, the stranger was being attacked. At 4 P.M. the friend again had hold of an ant by an antenna; the stranger was being pulled about. At 5 the friend seemed quite at home in the nest; the stranger was killed. The following morning I was still able to distinguish the friend; she seemed quite at home.

6th Aug. Put in a stranger and a friend at 8 A.M. At 8.30 both were attacked. 9 do., 9.30 do., 10 do., 11 do., 12.30 do.

6th Aug. Repeated the experiment at 2. Both ants hid themselves in corners. At 3.30 the stranger was being attacked; the friend was in a corner by herself. At 4.30 both were attacked. 5.30 do.

7th Aug. Put in a stranger and a friend at 8.30 A.M. At 8.45 both were being attacked. 9.30 do., 10 do.

Aug. 8. Put in a friend at 7 A.M. At 8 she seemed quite at home with the others. At 9 they had almost cleaned her. 9.30 she seemed quite at home with the others. 10 do.

12th Aug. Put in a friend and a stranger at 7 P.M. Both were immediately attacked. 7.15 they were being dragged about. 7.45 do, 8 do., 8.15 do.

13th Aug. Put in a friend at 6.30 A.M. At 7.50 two attacked her. At 8 she was being attacked by one ant, but another was cleaning her. 8.15 do. 8.45. Two were attacking her, one dragging at her by an antenna. 9 do., 9.30 do., 10 do., 10.30 do. Others had almost entirely cleaned off the paint.

At 5 P.M. put a friend and a stranger into the other nest. At 5.15 the friend seemed quite at home, and had been nearly cleaned; the stranger was being attacked. 5.30 do., 8.15 do. 7.15. Two of the ants were dragging the stranger out of the nest; the friend had been quite cleaned.

14th Aug. At 8.15 A.M. I put an ant from each half of the nest into the other. At 8.30 one was alone in the corner, the other was being attacked. At 9 both were being attacked. 9.30 do., 10.30 do.; 11.30 do., both, however, being almost cleaned.

Aug. 19. At 8 A.M. I put into each nest one from the other. The one was received amicably and cleaned, so that I lost sight of her. It was clear, however, that she was received in a friendly manner, because no fighting was going on. At 11 I put into the same nest another friend: at 11.30 she was all right, and, being cleaned at 12, I could no longer distinguish her.

The ant put into the other nest was not so well received. At 9.30, 12.30, and 11.30 she was being dragged about, but she was also being cleaned, and after 11.30 I lost sight of her.

Aug. 21. At 10.15 I again put into each nest an ant from the other. One was at once cleaned, and I could not find her. I should, however, certainly have seen her if she had been attacked.

The other was at first attacked by one of the ants; but this soon ceased, and they began to clean her. By 11.30 she was quite at her ease among the other ants and almost clean. After 12 I could not see her any more. At 1.40 P.M. I again put into each nest an ant from the other, accompanied, however, in both cases by a stranger. The contrast was most marked, and no one who saw it could have doubted that the friends and strangers were re-

spectively recognized as such, or that they themselves were fully aware of their position.

In the first nest the friend at once joined the other ants, who began to clean her. The stranger ran about in evident alarm, was pursued by the others, and took refuge in a corner. At 2 the friend was with the other ants, the stranger alone in a corner. At 2.25 the friend was almost cleaned, and after 2.30 we could no longer distinguish her: the stranger was still alone. At 3.40 she came out of her hiding-place and was attacked; after a while she escaped from the nest. At 5.30 she met one of the ants, and a battle at once began. I separated the combatants and put the stranger back near her own nest, which she at once entered, and where she was soon cleaned by her own friends.

I will now describe the adventures of the other couple. The friend immediately joined the other ants; the stranger was hunted about and soon seized. At 2 the friend was all right, the stranger being dragged about. At 2.30 ditto. The stranger was soon killed. The friend, whom I watched at intervals till 6.30, continued on the best terms with the others; it was quite clear, therefore, that they did not regard her as a stranger. She herself was not afraid of, and did not avoid them. Still for some time she apparently wished to return home. She came out of the nest and tried to find her way home to her own nest. I put her back again, however, and by the evening she seemed to have accustomed herself to the change. I opened the door of the nest soon after 5; but she showed no wish to leave her newly acquired friends.

Sept. 1. At 11 A.M. I again put into each nest an ant from the other and a stranger. In the one nest the friend joined the other ants, and seemed quite at home; the stranger, on the contrary, endeavoured to conceal herself, and at length, at 4 in the afternoon, escaped from the nest.

In the other division the friend also appeared quite at home. The stranger, on the contrary, endeavoured to escape, but in the course of the afternoon was attacked and killed.

Oct. 15. At 8 A.M. I repeated the same experiment. In the first nest, up to 10 A.M., neither ant was attacked; and it is curious that the stranger was licked and, indeed, almost cleaned. Soon afterwards, however, the ants began to attack her, and at 3 P.M. she was dead, the friend, on the contrary, being quite at home. Still the following day at midday I found her out of the nest (all the rest being within). This almost looks as if, though safe, she

did not feel at home; and I accordingly put her back to the other nest, which she at once entered.

In the other division the friend was soon nearly cleaned, and the stranger partly so. The friend seemed quite at home. At 12.30 the stranger was being dragged about by three ants; but after this I lost sight of her.

Nov. 10. At 11.30 put into one of the divisions a friend and a stranger. At 12 the friend was all right, the stranger was being dragged about by an antenna. From this time till 7 P.M. the stranger was continually being dragged about or held a prisoner, while the friend was quite at home.

Nov. 11. At 10.15 I put into the other division a friend and a stranger. At 11 the friend was quite at home, and the colour with which I had marked her had been almost cleaned off. The stranger, on the contrary, was being dragged about by two of the ants. After this, however, I could not find her. She had, I think, escaped from the nest.

Nov. 12. I therefore, the following day at 11.30, again put a friend and a stranger into this division of the nest. The friend seemed quite at home. One of the ants at once seized the stranger by an antenna and began dragging her about. I will give this observation in detail out of my note-book.

At 11.45. The friend is quite at home with the rest; the stranger is being dragged about.

At 12. The friend is all right. Three ants now have hold of the stranger by her legs and an antenna.

At 12.15, 12.30, 12.45, and at 1 similarly occupied.

At 1.30 similarly engaged. One now took hold of the friend, but soon seemed to find out her mistake and left go again.

At 1.45. The friend is all right. The stranger is being attacked. The friend also has been almost cleaned, while on the stranger the colour has been scarcely touched.

At 2.15. Two ants are licking the friend, while another pair are holding the stranger by her legs.

At 2.30. The friend is now almost clean; so that I could only just perceive any colour. The stranger, on the contrary, is almost as much coloured as ever. She is now near the door and, I think, would have come out, but two ants met her and seized her.

At 3. Two ants are attacking the stranger. The friend was no longer distinguishable from the rest.

At 3.30, 3.40, and 5 engaged as above.

At 6.0. The stranger now escaped from the nest, and I put her back among her own friends.

The difference of behaviour to these two ants was therefore most marked.

The friend was gradually licked clean, and except for a few moments, and that evidently by mistake, never attacked. The stranger, on the contrary, was not cleaned, was at once seized, was dragged about for hours with only a few minutes' interval, by one, two, or three assailants, and at length made her escape from the nest at the time when no other ant was out.

Dec. 11. At 10 A.M. I again put in a friend and a stranger. The friend was not attacked, and consorted peaceably with the rest. I found her again all right on the following morning. The stranger, on the contrary, was soon attacked and killed.

Dec. 22. Repeated the same experiment. The stranger was attacked and driven out of the nest. The friend was received quite amicably.

Dec. 26. Ditto. The friend was received as usual. I lost sight of the stranger, who probably escaped.

Dec. 31. Ditto. In this case the stranger, after being dragged about some time in the nest, made her escape. But even outside, having met with an ant accidentally, she was viciously attacked.

Jan. 15. Ditto.

Jan. 16. I put in two friends; but thinking the preceding experiments sufficient, I did not on this occasion add a stranger. Neither of the friends was attacked.

Jan. 19. Put in two friends at 11 A.M. Neither was attacked, and the following morning they were all right amongst the rest.

Jan. 22. Put in three friends, with the same result.

Jan. 24. „ two „ „

Jan. 26*. „ three „ „

These details are, I fear, tedious, but they may be worth giving, because a mere statement of the general facts without particulars would not convey so clear an idea of the result. The following table shows it in a condensed form:—

* Since this paper was read, I have continued these observations, viz.:— On Feb. 11 put in two friends, on Feb. 12 three, on Feb. 13, 15, and 19, and on March 11 and 12, one friend, on March 18 two, on April 21 one, and on April 22 and 23 two friends; but in none of these instances were the friends attacked

Experiments with Ants of different Nests.

Separation of Nest, Aug. 4, 1875.

	F. fusca. Friend.	*F. fusca.* Enemy.		*Myrmica ruginodis.* Friend.	*Myrmica ruginodis.* Stranger.
8 Aug.	......	Attacked.			
13 „	......	„			
16 „	Not attacked.				
20 „	......	Attacked.			
22 „	Not attacked.	„			
3 Sept.	„	Not attacked.	Not much watched.		
17 „	„	„			
3 Oct.	„	„			
15 Mar.	„	Attacked.	3 Oct.	Not attacked.	Attacked.
4 June	„	Killed.	18 „	„	Killed.
5 „	„	Attacked.	19 „	„	„
5 „	„	„	20 „	„	„
10 „	„	Attacked and killed.	24 „	„	„
				„	„
3 July	Attacked.	Attacked.	31 „	„	„
10 „	„	......	7 Nov.	„	„
16 „	„				
16 „	„				
17 „	Not attacked.				
17 „	„				
20 „	„	Attacked and killed.			
6 Aug.	Attacked.	Attacked.			
6 „	„	„			
7 „	„	„			
8 „	Not attacked.				
12 „	Attacked.	„			
13 „	„				
13 „	Not attacked.	„			
14 „	Attacked ?				
14 „	„ ?				
19 „	„				
21 „	Not attacked.				
21 „	„				
21 „	„				
21 „	„	Attacked and killed.			
1 Sept.	Not attacked.	Ran away.			
1 „	„	Attacked.			

	F. fusca. Friend.	Enemy.
15 Oct. ...	Not attacked.	,,
15 ,, ...	,,	,,
10 Nov. ...	,,	,,
11 ,, ...	,,	,,
12 ,, ...	,,	,,
11 Dec. ...	,,	,,
22 ,, ...	,,	Escaped from the nest.
26 ,, ...	,,	Not attacked.
31 ,, ...	,,	Attacked.

Some further observations on *F. fusca*, viz. on January 15th, when a stranger was attacked, whereas twice on the 16th, twice on the 19th, thrice on the 22nd, twice on the 24th, and thrice on the 26th of the same month, all resulted in a friend not being attacked*.

I must, however, point out one thing which must be taken into consideration. As I sometimes transposed ants from one division of the nest to the other, it might be said that some of the friends were among those which had been brought more recently from the other half of the nest.

Of the ants thus transposed, there were, however, altogether, in nest No. 5, only thirteen,in nest No. 4 twenty-three, some of which, moreover, must certainly have been among those that died. After the beginning of November all the transfers were made from No. 4 into No. 5. Since December last thirty-one ants have been so transferred; even assuming then that I had unluckily hit upon all the transferred ants (which is of course little short of an impossibility), eight of them, at any rate, had not been in nest No. 5 since August 1875.

Thus, then, for more than a year these ants remembered their old companions, as is shown by the fact that they received them amicably while they attacked strangers. It is surprising that the ants of a nest should all know one another; but that this should be still the case after more than a year's separation seems to me not the least marvellous point connected with them.

* The following cases have been added since the reading of this paper:— Feb. 11 two friends, Feb. 12 three, Feb. 13, 15, and 19, and March 11 and 12, one friend, March 18 two friends, April 21 one, and April 22 and 23 two friends, none of which when introduced were attacked.

Contrast in Behaviour of different kinds of Ants.

The behaviour of *Lasius flavus* offers a surprising contrast to that of *F. fusca.* I was anxious to see whether the colonies of this species, which are very numerous round my house, were in friendly relations with one another. With this view, I kept a nest of *L. flavus* for a day or two without food and then gave them some honey, to which they soon found their way in numbers. I then put in the midst of them an ant of the same species from a neighbouring nest; the others did not attack, but, on the contrary, cleaned her—though, from the attention she excited and the numerous communications which took place between her and them, I am satisfied that they knew she was not one of themselves. After a few minutes she accompanied some of the returning ants to the nest. They did not drag nor apparently guide her; but she went with them quite freely. This I repeated several times with the same result.

I then took four ants, two from a nest about 500 yards from the first in one direction, the other from an equal distance in another. In all cases the result was the same. I then got a few from a colony about half a mile off. These also were most amicably received, and in every case the stranger went of her own accord to the nest. One of the strangers was, indeed, dragged about half way to the entrance of the nest, but was then left free and might have run away if she had liked. She, however, after wandering about for about half a minute, voluntarily entered the nest. In one or two cases the stranger ran as quickly and straight to the nest as if she had been there over and over again. This, I suppose, can only have been by scent; and certainly no hounds in full cry could have pursued their game more directly or with less hesitation. In other cases, however, they were much longer before they went in. To satisfy myself that these facts were not owing to the nest having been taken from that of colonies or allies, I subsequently procured some ants of the same species from a nest in Hertfordshire; and they also behaved in a similar manner. In one or two cases they seemed to be attacked, though so feebly that I could not feel sure about it; but in no case were the ants killed.

The following fact surprised me still more. I put an ant (Aug. 31) at 9 A.M. on a spot where a number of *F. flava* (belonging to one of my nests of domesticated ants) had been feeding some hours previously, though none were there, or, indeed, out at all, at the

moment. The entrance to the nest was about 8 inches off; but she walked straight to it and into the nest. A second wandered about for four or five minutes and then went in; a third, on the contrary, took a wrong direction, and, at any rate for three quarters of an hour, did not find the entrance.

Very different is the behaviour of *L. niger* under similar circumstances. I tried the same experiment with them. There were no communications with the antennæ, there was no cleaning; but every ant which the stranger approached flew at her like a little tigress. I tried this experiment four times; each stranger was killed and borne off to the nest.

Suspected Cannibalism.

Ants have even been suspected of cannibalism by some writers *, because those which are found dead are generally more or less shrivelled, and the large females even are reduced almost to an empty shell. Huber's statement that their affection for their queens induces them to brush and lick them for days after death, has even been regarded as evidence of cannibalism rather than of affection. On this point, however, further evidence is required.

Experiments Testing the Senses. Sight.

In order to test how far they are guided by sight, I made various observations and experiments, the accompanying woodcuts being reduced copies of tracings of some of the tracks made by the ants during the course of the observations. I shall commence with experiment No. 2.

Exp. 2.—Feb. On the parade-ground (see fig. 2) I placed upright a common cylindrical lead-pencil $\frac{1}{4}$ inch in diameter and 7 inches long, fastened with sealing-wax to a penny-piece. Close to the base of the pencil (A) I brought the end of a paper bridge (B) leading to the nest, and then placed a shallow glass with larvæ at C, 4 inches from the base of the pencil. I then put an ant to the larvæ; when she had become acquainted with the road, she went very straight, as is shown in the woodcut (fig. 2). In one case, at the point E, she dropped her larva and returned for another. When she returned on the next journey and was on the glass, I moved it 3 inches, to D, so that the end of the glass was 6 inches from the base of the pencil. If she were much guided by sight, then she would have little or no difficulty in finding her way

* See, for instance, an interesting communication by Mr. Elwin, Sci. Gossip, Nov. 1870, p. 243.

Fig. 2.

Routes followed in experiment No. 2, as detailed above.

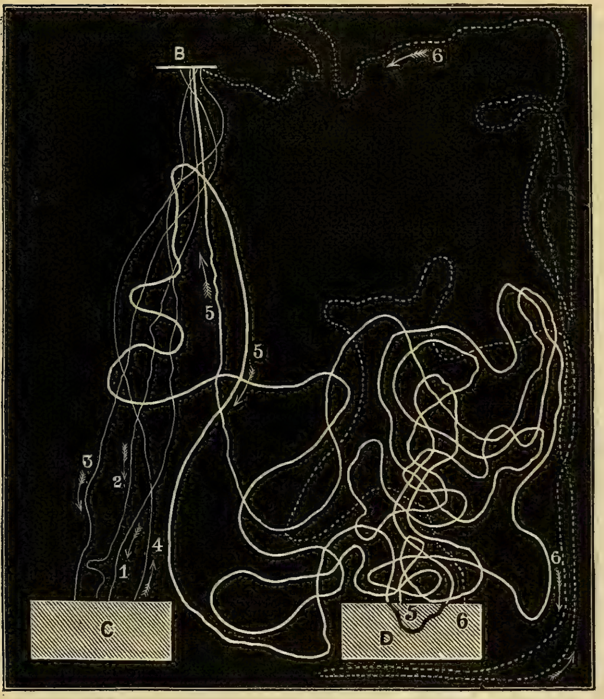
A, position of pencil. B, paper bridge. C and D, glass with larvæ. E, point where larva dropped, the opposite arrow and loop marking return route. 1, 2, 3, 4, comparatively straight paths to the glass. 5, 5, circuitous route on shifting of glass. * different access to nest.

back. Her pathway, however, which is traced on the paper, shows that she was completely abroad; and, after all, she got back to the nest by a different route (5).

I then varied the experiment as subjoined, and as shown in the woodcut (fig. 3).

*Exp.*3.—I connected the parade-ground with the nest by a paper bridge, the end of which is shown at B (fig. 3), and which came down about an inch from the pole supporting the nest. This pole rises 18 inches above the parade-ground. I then put the glass tray (C) with larvæ as before, 12 inches from the base of the pole, and put an ant to the larvæ. When she had learnt her way I traced four of her routes, as shown in the thin lines 1, 2, 3, 4. I then on her next journey (5, thick white line), when she was on the tray (C), moved it three inches to D, as shown in the figure, and again traced her routes. The contrast is very striking between the relatively straight thin white lines 1, 2, 3, 4 of the four journeys when familiar with the road; whereas in the broad white line No. 5 the zigzag twistings show how much difficulty the ant

Fig. 3.



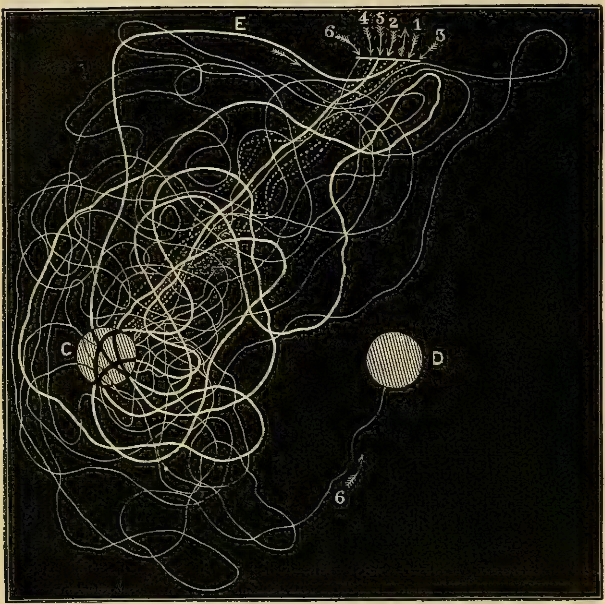
Routes followed in experiment No. 3, as mentioned in text.

B, paper bridge. C, glass tray with larvæ, its first position; and D its position when shifted. 1, 2, 3, 4, thin white lines indicating the comparatively straight routes. 5, thick white line, and 6, dotted line showing tortuous paths when glass had been altered in position. The arrows indicate directions travelled.

experienced in finding her way. Again the dotted sinuous white line (6) shows the course adopted on a subsequent journey.

Exp. 4.—I then again varied the experiment as follows:—I placed the larvæ in a small china cup on the top of the pencil, which thus formed a column 7½ inches high. The cross line close to the arrows (fig. 4) is as before, the base of the paper bridge going to the nest. C shows the position of the penny on which the pencil is supported. The dotted white lines 1, 2, 3, 4 show the routes of a marked ant on four successive journeys from the nest to the base of the pencil. I then moved the pencil 6 inches to D, and the two following routes are marked 5 and 6. In one of them, 5 (thick white line), the ant found a stray

Fig. 4.



Routes followed in experiment No. 4, as described in text.

Cross line at the six arrows represents paper bridge going to nest. C, china cup on top of pencil. D, pencil moved. E, where stray larvæ were found. 1, 2, 3, 4, dotted lines show the nearly direct journeys. 5, thick white line (crossing C in black) of route returning to nest E, being position of larva in the course. 6, very circuitous thin white line of track from nest to pencil D.

larva at E, with which she returned to the nest, without finding the pencil at all. On the following journey, shown in fine white zigzag line (6), she found the pencil at last, but, as will be seen, only after many meanderings.

Exp. 5.—I then repeated the observation on three other ants (see figs. 5–7) with the same result: the second was 7 minutes before she found the pencil, and at last seemed to do so accidentally; the third actually wandered about for no less than half an hour, returning up the paper bridge several times.

Other experiments somewhat similar to the preceding, the results of which are shown in the figures 6 and 7, seem to prove that this species of ant, at any rate, guides itself but little by sight. This, which I had not at all anticipated, seems to follow from the fact that after the pencil and tray of larvæ had been

Fig. 5.

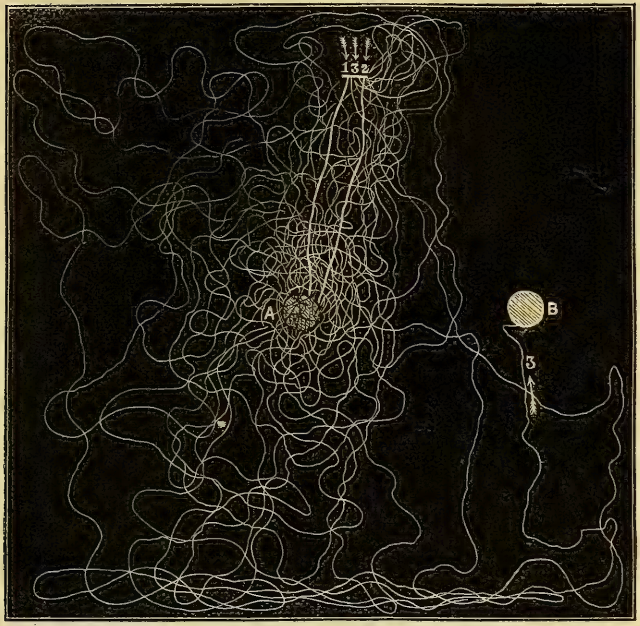


Diagram of complex path traversed in experiment 5.

A, first position of pencil. B, second position of pencil. 1, 2, straight lines of two tracks of the observed ant. 3, winding narrow white line, showing course pursued by the same ant before arriving at B, when the position of the pencil was unchanged.

removed but a short distance to the right or left, the ants on their journey to the shifted object travelled very often backwards and forwards and around the spot where the coveted object first stood. Then they would retrace their steps towards the nest, wander hither and thither from side to side between the nest and the point A, and only after very repeated efforts around the original site of the larvæ reach, as it were, accidentally the object desired at B.

Another evidence of this consists in the fact that if when *L. niger* were carrying off larvæ placed in a cup on a piece of board, I turned the board round so that the side which had been turned towards the nest was away from it, and *vice versâ*, the ants always returned over the same track on the board, and, in consequence, directly away from home.

If I moved the board to the other side of my artificial nest, the

Fig. 6.

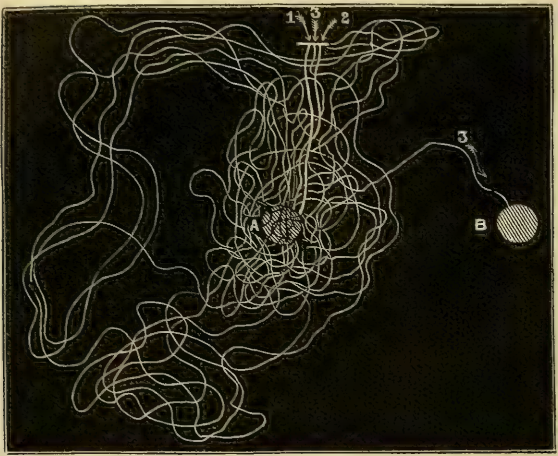


Diagram representing three tracks of an ant in another experiment.

A, the first position of pencil and the food, towards which and from the base-line of nest 1 and 2 lead by nearly direct broadish white lines to A. When the latter was removed to B the ant, in its effort to reach this, pursued the narrow white winding line ending in 3 ⟶

result was the same. Evidently they followed the road, not the direction.

I may here note that the diagrams figs. 2–7 are careful reductions of large tracings made during the experiments. Though not absolutely correct in every minute detail of contour, they are exact for all practical purposes. As the ants pursued their way, pencil-markings in certain instances, and coloured lines in others, were made so as to follow consecutively the paths pursued.

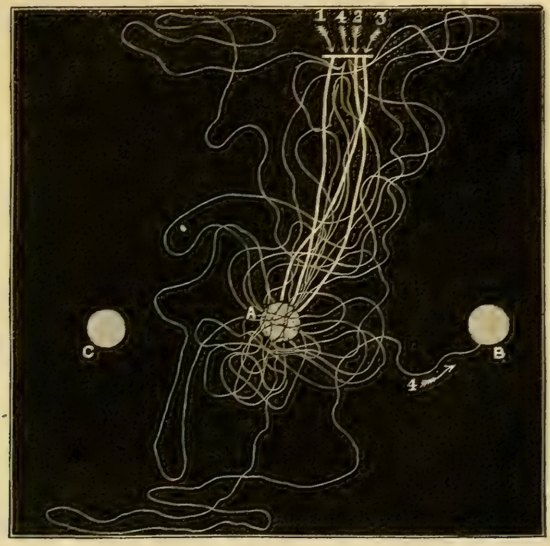
Hearing.

As regards their sense of hearing, I have in my previous paper recorded my unsuccessful experiments in this direction. Approaching an ant which was standing quietly, I have over and over again made the loudest and most shrill noises I could—using a penny pipe, a dog-whistle, a violin, as well as the most piercing and startling sounds I could produce with my own voice, but without effect. At the same time I by no means would infer from this that they are really deaf, though it certainly seems that their range of sounds is very different from ours. We know that certain

allied insects produce a noise by rubbing one of their abdominal rings against another. Landois is of opinion that ants also make sounds in the same way, though these sounds are inaudible to us. Our range is, however, after all very limited, and the universe is probably full of sounds which we cannot perceive. There are, moreover, in the antennæ of ants certain curious organs which may be of an auditory character.

These consist of three parts, a small spherical cup, opening to the outside, a long narrow tube, and a hollow body, shaped

Fig. 7.



Another tracing showing a similar Experiment. 1, 2, 3, the direct broad lines towards A; and 4, the complicated track made when reservoir of larvæ was removed to B.

like an elongated clock-weight. They are about 10 in number, and may serve to increase the resonance of sounds, acting, in fact, to use the words of Prof. Tyndall, who was good enough to look at them with me, like microscopic stethoscopes. Several of the other segments of the antenna also contain one of these curious organs.

Dependence on Slaves.

Huber mentions that the Amazon ants (*Polyergus rufescens*) are

so dependent on their slaves as to perish in two or three days if separated from them. That this is the case, has been shown by subsequent observers. It is no use giving them food—say honey; they will not touch it. Or rather, they walk carelessly over it, smear their legs, and die, if a slave is not put in to clean and dry them. I found, however, that I could keep even a single *Polyergus* alive for more than three months by giving her a slave for about an hour a day to attend on and feed her. I have one at this moment which has been so treated since November, and which is still alive and well*.

Division of Labour.

I mentioned in my last paper that in the autumn of 1875 I noticed an ant belonging to one of my nests of *F. fusca* out feeding alone. The next day the same ant was again out by herself, and for some weeks no other ant, so far as I observed, came out to the food. I did not, however, watch her with sufficient regularity. This winter, therefore, I have kept two nests under close observation, having arranged with my daughters and their governess, Miss Wendland (most conscientious observers), that one of us should look at them once an hour during the day. One of the nests contained about 200 individuals, the other, a nest of *P. rufescens* with the usual slaves, about 400. The mistresses themselves never come out for food, leaving all this to the slaves.

We began watching on the first of November, but did not keep an hourly register till the 20th, after which date the results are given in the following tables. Table No. 1 relates to the nest of *F. fusca*, and the ants are denoted by numbers. The hours at which we omitted to record an observation are left blank; when no ant was at the honey, the square is marked with an 0. An ant, marked in my register as No. 3, was at this time acting as feeder to the community.

The only cases in which other ants came to the honey were at 2 P.M. on the 22nd Nov., when another ant came out, whom we registered as No. 4, another on the 28th, registered as No. 5. Other ants came out occasionally, but not one came to the honey (except the above mentioned) from the 28th Nov. till the 3rd Jan., when another (whom we registered as No. 6) began feeding. After this a friend visited the honey once on the 4th, once on the 11th, and again on the 15th, when she was registered as No. 7.

* April 15. She is still well.

Table No. 2 is constructed in the same way, but refers to the nest of *Polyergus* and *F. fusca*. The feeders in this case were, at the beginning of the experiment, those known to us as Nos. 5, 6, and 7. On the 22nd Nov. a friend, registered as No. 8, came to the honey, and again on the 11th Dec.; but with these two exceptions the whole of the supplies were carried in by Nos. 5 and 6, with a little help from No. 7.

Thinking now it might be alleged that possibly these were merely unusually active or greedy individuals, I imprisoned No. 6 when she came out to feed on the 5th. As will be seen from the table, no other ant had been out to the honey for some days; and it could therefore hardly be accidental that on that very evening another ant (then registered as No. 9) came out for food. This ant, as will be seen from the table, then took the place of No. 6, and (No. 5 being imprisoned on the 11th Jan.) took in all the supplies, again with a little help from No. 7. So matters continued till the 17th, when I imprisoned No. 9, and then again, *i. e.* on the 19th, another ant (No. 10) came out for the food, aided on and after the 22nd by another, No. 11. This seems to me very curious. From the 1st Nov. to the 5th Jan., with two or three casual exceptions, the whole of the supplies were carried in by three ants, one of whom, however, did comparatively little. The other two are imprisoned, and then, but not till then, a fresh ant appears on the scene. She carries in the food for a week, and then, she being imprisoned, two others undertake the task. On the other hand, in Nest 1, where the first foragers were not imprisoned, they continued during the whole time to carry in the necessary supplies.

The facts therefore certainly seem to indicate that certain ants are told off as foragers, and that during winter, when little food is required, two or three are sufficient to provide it.

Tables illustrating Experiments on Division of Labour.

TABLE I.—*Slaves of* Formica fusca. Nest No. 1.

Date.	6.30.	7.	8.	9.	10.	11.	12.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Nov. 20 .	0	0	0	0	0	0	0	N 3	0	0	0	0	0	0			
21...	...	N 3	0	0	0	0	0	0	Friend marked	...	...	0	0	0			
22...	0	0	N 3	0	0	N 3	N 3	0	N 4	N 4	0	0	N 4	0	...	...	0
23...	N 4	0	N 4	0	0	0	0	0	0	...	...	0	...	0			
24...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25...	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
26...	0	0	0	0	0	0	0	...	0	...	0	0	0	0	...	...	0
27...	0	0	0	0	0	N 4	0	N 3	0	0	0	0	0	0	N 3	0	0
28...	0	0	0	0	0	0	0	N 5	0	0	N 5	N 5					
29...	0	0	N 4	0	0	0	0	N 3	0	N 3	0	0	0	0	0	0	
30...	0	0	N 3	N 3	0	0	0	0	0	0	0	0	0	0	0	0	
Dec. 1..	...	0	0	0	0	0	0	0	0	0	0	0	N 4	0	0	0	
2...	0	0	N 4	N 4	0	0	N 3, 4	0	0	0	0	0	0	N 4	N 4	0	
3...	0	0	N 4	0	0	0	0	0	0	N 3	0	0	N 3	0	N 3	N 3	0
4...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	...	0
5...	...	0	N 3	0	0	0	0	0	...	0	0	0	0	0	0	...	0
6...	...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7...	...	0	0	0	N 4	0	0	0	0	0	0	0	...	0			
8...	0	0	0	0	0	0	0	0	0	0	0	0	0				
9...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	...	0	0

10...	...	0	0	0	0	...	...	0	0	0	0	0	0	0			
11...	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	
12...	0	0	0	0	0	0	0	N 3	N 4	N 3	0	0	0	0	0	N 3	
13...	N 3	0	0	0	0	0	0	0	0	N 3	0	0	0	0	0	N 3	
14...	...	0	0	0	0	0	0	0	0	0	0	0	0	0	...	0	0
15...	...	0	N 3	0	0	0	0	0	0	0	0	0	0	...	0	0	0
16...	0	0	0	0	0	0	N 3	0	0	...	0	0	0	0	...	0	0
17...	...	0	...	0	0	...	0	0	0	0	0	0	0	0	0	0	0
18...	...	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0
19...	...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20...	...	0	0	0	0	0	N 3	N 3	0	0	0	0	0	0	0	0	0
21...	0	0	0	0	0	0	0	0	0	0	0	N 3	0	0	0	0	0
22...	0	0	0	0	0	0	0	0	0	0	0	0	0				
23...	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
24...	0	0	0	0	0	0	0	0	0	0	N 3	0	0	0	0	0	N 3
25...	0	0	0	0	0	...	...	0	0	0	0	0	0	...	0	0	
26...	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0
27...	0	0	0	0	0	0	0	0	0	0	N 3	...	0	...	0	0	N 3
28...	0	...	N 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29...	...	...	0	0	N 3	0	0	0	0	0	...	0	0	0	0	0	0
30...	...	0	0	N 3	0	0	0	0	0	0	0	0	0	0	0	0	0
31...	...	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0
Jan. 1...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2...	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0
3...	0	0	...	Friend N 6	0	0	0	0	0	0	0	0	0	0	0	0	0
4...	0	N 6	N 6	N 6	0	0	0	...	...	...	...	...	...	N 6	...	N 6	0
5...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6...	N 6	0	N 6	0	0	0	0	0	0	0	...	...	...	...	N 6	0	0
7...	0	0	0	0	0	...	...	N 6	0	0	N 6	0	0	...	0	0	0

TABLE I. (*continued*).

Date.	6.30.	7.	8.	9.	10.	11.	12.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Jan. 8...	...	0	0	N 5	N5&6	0	0	0	0	N 3	0	0	0	0	N 5	0	N 5
9...	0	0	0	0	0	0	0	0	...	0	0	0	0	...	0	0	0
10...	0	0	N 3	0	0	0	...	0	N 3	0	0	0	0	0	0	0	0
11...	...	0	N 6	N 3	0	0	0	0	Friend feeding	0	0	0	0	0	0	0	0
12...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13...	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0	0	0
14...	0	N 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 ...	0	0	0	0	0	0	Friend marked N 7	0	0	0	0	0	0	0	0	0	0
16...	0	0	0	N7&3	0	0	N 3	0	0	0	0	N 7	0	0	0	0	0
17...	...	0	N 7	0	0	N 7	N 7	0	0	0	0	0	N 6	0	0	0	0
18...	0	N 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19...	0	0	N 6	0	0	0	0	0	0	0	0	0	0	0	0	N 6	0
20...	...	0	0	0	0	0	0	0	0	N 6	0	0	0	...	0	0	0
21...	0	N 6	0	N 3	0	...	...	0	0	0	0	0	0	0	0	0	0
22...	0	N 6	0	0	0	0	0	0	N 6	0	N 6	0	0	...	0	0	0
23...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24...	0	0	0	0	0	0	0	0	0	0	0	0	0	...	0	0	0
25...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26...	0	0	0	0	0	N 3	0	0	0	...	0	N 3	0	0	0	0	0
27...	...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28...	0	0	Friend N 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29...	0	0	N 8	0	0	0	0	0	0	N 8	0	0	0	0	0	0	0

30...	0	0	0	0	Friend, marked her N 9	0	0	0	0	0	0	0	0	0	0	0	0
31...	0	0	0	0	0	0	0	0	0	0	0	0	N 6	0	0	0	0

(With the permission of the Council I have added the following, so as to extend the observations to three months.

Feb. 1...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2...	0	0	0	0	0	0	0	0	0	...	0	0	0	N 8	0	N 8	0
3...	...	N 9	0	0	N 9	0	0	0	0	0	0	0	...	0	0	0	0
4...	0	0	0	0	0	0	0	0	0	N 6	0	N 6	0	0	0	0	0
5...	0	0	0	0	0	0	0	0	0	...	0	0	0	N 6	0	0	0
6...	0	0	0	0	0	0	0	0	0	0	0	0	0	N 8	0	0	0
7...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N 8	0	0
9...	0	0	0	0	0	0	0	0	0	0	0	0	N 8&9	0	N 10	0	0
10...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13...	0	0	0	0	0	N 11	0	0	0	0	0	0	0	0	0	0	0
14...	...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15..	0	0	0	0	0	0	0	0	0	0	Friend feeding.	0	0	0	0	0	0
16...	...	0	0	0	0	0	0	0	0	0		0	N 8	N 9	0	N 8	0
17...	...	0	0	0	0	...	...	0	0	0	0	0	0	0	0	0	0
18...	0	0	0	...	...	0	0	0	0	0	0	0	0	0	0	0	0
19 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20...	...	0	0	0	0	0	0	0	0	0	0	0	0	N 8	0	0	0
1...	0	0	0	0	0	0	0	0	0	0							
22...	...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24...	...	...	0	0	0	N 8	0	0	0	0	0	0	0	0	0	0	0

TABLE II.—*Slaves of* Polyergus.

Date.	6.30.	7.	8.	9.	10.	11.	12.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Nov. 20...	N 5	0	0	0	0	0	N 5	0	0	N 5	N 5	N 5	0	N 6	N 7		
21...	0	0	0	N 5	0	0	N 5	0	...	...	...	0	0	0			
	Friend marked																
22...	N 8	N 5	N 7	0	0	N 5	N 7	N 5	0	0	N 5	0	N 5	0			
23...	0	0	N 5	0	0	0	0	0	0	...	...	0	...	0			
24...	0	N 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25...	0	N 5	0	0	N 5	0	N 5	N 5	N 5	N 5	N 5	0	0	0			
26...	0	0	0	0	0	0	0	...	0	...	0	N 6	0	0	...	...	N 6
27...	0	N 6	N 5	0	N 5	0	N 5	N 5	N 6	N 5	0	N 6	0	N 5	0	N 6	N 6
28...	0	0	0	0	0	0	0	N 5	0	0	N 5	N 5					
29...	0	0	N 5	0	0	0	0	0	0	0	0	0	0	0	0	0	
30...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N 6	0	
Dec. 1...	...	0	0	0	0	0	N 6	0	0	0	N 6	0	0	N 6	N 6	0	
2...	0	N 6	0	0	0	N 6	N 6	0	0	N 6	0	0	0	N 6	0	N 6	0
3...	0	0	0	0	0	...	N 7	0	0	N 6	0	0	0	0	0	...	0
4...	0	N 6	0	0	0	0	0	0	0	0	N 6	0	0	0	0	0	0
5...	...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	...	0
6...	...	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0
7...	0	0	0	0	0	0	0	0	0	0	0	0	...	0			
8...	0	N 6	N 6	N 6	0	0	N 6	N 6	0	0	N 6	0	N 6				
9...	N 6	N 6	0	0	0	0	0	0	...	0	0	N 6	0	0	...	0	0
10...	...	0	0	0	0	...	...	0	0	0	0	0	0	0			
11...	0	0	0	0	0	0	0	0	...	0	0	0	0	N 6	0	0	
			Friend.														

12...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N 6
13...	N 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	...	0	0
15...	...	0	0	0	0	0	0	0	0	0	0	N 6	0	...	0	0	0
16...	0	0	0	0	0	0	0	0	0	...	0	0	0	0	...	0	0
17...	...	0	...	0	N 6	0	0	N 7	0	0	0	0	N 7	0	0	0	0
18...	...	0	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0
19...	...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20...	...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21...	N 6	0	N 6	N 6	0	0	N 6	0	0	0	N6&5	0	N 5	N5&6	0	N5&6	N 5
22...	0	0	0	0	N 6	0	0	N 5	N 5	0	N 5	0	0				
23...	0	0	N 5	0	0	0	0	N 5	0	0	0	N 5	0	0			
24...	0	0	N 5	0	0	0	N 5	0	0	0	0	N 5	0	0	N 5	0	0
25...	0	0	0	N 5	0	...	...	N 5	0	0	0	N 5	0	...	0	0	
26...	0	0	0	N 5	0	0	N 5	0	0	N 5	0	0	0	0	0	0	0
27...	0	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0
28...	0	0	N 6	0	N 5	0	0	0	0	0	0	0	N 6	0	N 6	0	0
29...	...	...	0	N 6	0	N 6	0	0	0	N 6	0	N 5	0	0	N 5	0	0
30...	...	N 5	N 5	0	0	0	N 5	N 5	0	0	0	0	N 5	0	0	0	0
31...	...	N 5	0	0	0	0	0	0	0	0	N 6	0	0	0	0	0	0
Jan. 1...	0	0	0	0	0	0	0	0	0	0	0	0	N 6	0	0	0	0
2...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 ..	0	0	N 6	N 6	0	N 6	0	...	...	...	...	...	...	0	0	0	0

TABLE II. (*continued*).

Date.	6.30	7.	8.	9.	10.	11.	12.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Jan. 5...	0	0	0	0	0	0	0	Impris. N 6	0	0	0	0	0		0	0	0
6...	0	0	0	0	0	0	0	0	0	0	...	...	...	0	0	Friend feeding	0
7...	0	0	0	0	0	...	...	0	0	0	0	0	0	0	0	0	0
8...	...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10...	Friend marked N 9	0	0	0	0	0	...	0	0	0	0	N 9	N 7	N 9	0	N5&9	0
11...	...	0	0	Impris. N 5	0	0	0	0	0	0	0	0	0	0	0	0	0
12...	0	N 9	0	0	0	0	0	0	0	0	0	0	N 9	0	0	0	N 9
13...	0	N 9	0	0	0	...	0	0	0	0	0	0	0	0	0	0	N 9
14...	0	0	0	0	0	0	0	0	0	0	N 9	0	0	0	0	N 9	0
15...	0	0	0	0	0	0	0	0	0	0	0	N 9	0	N 9	0	N 9	0
16...	N 9	0	0	0	0	0	0	0	0	0	0	N 9	N 9	N 9	0	0	N 9
17...	...	0	0	0	0	0	0	Impris. N 9	0	0	0	0	0	0	0	0	0
18...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19...	0	0	Friend marked N 10	0	0	0	N 10	0	N 10	0	N 10	0	0	0	0	0	0

20...	...	0	0	0	0	0	0	0	0	0	0	N 7	0	...	0	0	0
21...	0	0	0	0	0	...	...	0	0	0	0	0	Impris. N 7	...	N 10	0	0
22...	0	0	0	0	0	0	0	0	Friend. marked N 11	0	0	0	0	N 11	0	0	N 11
23...	0	0	N 11	0	0	0	0	0	0	0	0	N 11	0	Friend marked N 12	N 10	0	0
24...	N 11	0	0	0	0	0	0	0	0	0	N 11	0	0	...	N 11	0	0

I now put back No. 7.

25...	0	N 11	0	N 7	0	0	N 11	0	0	0	N 11	0	N 11	N 11	0	0	0
26...	0	0	0	0	0	0	0	0	0	...	0	0	N 11	0	0	0	0
27...	...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

I put back Nos. 5 and 6.

28...	N 11	0	0	0	0	0	0	0	0	0	0	N 5	0	0	N 12	0	0
29...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30...	0	N 6	0	0	N 6	0	N 6	0	N 6	0	0	N 6	0	0	0	0	0
31...	0	0	0	0	0	0	0	0	0	0	0	0	N 6	0	0	0	0

With the permission of the Council I have in this case also added the following, so as to extend the observations to three months.

TABLE II (*continued*).

Date.	6.30	7.	8.	9.	10.	11.	12.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Feb. 1...	0	0	0	0	0	0	0	0	0	0	0	0	N 11	0	N 6	0	0
2...	0	0	0	0	0	0	0	0	0	...	0	0	N 11	0	0	0	0
3...	...	0	0	0	0	0	0	0	0	0	0	0	N 6	...	0	0	0
4...	0	0	0	0	0	0	0	0	0	0	N 6	0	0	0	0	0	0
5...	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0	N 11
6...	0	N 11	0	0	0	0	N 11	0	0	0	0	0	0	0	0	0	0
7...	0	0	N 11	0	0	0	0	N 11	0	0	N 11	N12&6	N 7	N 11	0	0	N 6
8...	N 11	0	0	N 12	N 11	0	N 12	0	N 11	0	0	0	0	N 7	0	0	0
9...	0	N 11	0	0	N 11	0	N 11	0	0	0	0	0	0	0	N 12	0	0
10...	0	0	N 11	0	0	0	0	0	0	0	0	0	0	0	0	0	N 11&12
11...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12...	0	N 11	0	N 11	0	N 11	0	0	N 11	0	N 11	0	0	0	N 10	N 11	0
13...	0	0	0	0	N 11	N 12	0	0	0	0	0	0	N 11	0	N 10	0	0
14...	...	N 11	0	0	0	0	0	0	0	0	0	0	N 11	0	0	0	N 11
15...	0	0	0	0	0	0	0	0	N 11	0	0	0	0	0	0	0	0
16...	...	0	N 11	0	0	0	0	0	0	0	0	0	0	0	0	N 11	0
17...	..	0	0	0	0	0	0	...	0	0	0	0	0	0	0	N 11	0
18...	0	0	0	0	0	...	...	0	0	0	0	0	0	0	0	N 11	0
19...	0	0	N 11	0	N 11	0	0	N 11	0	0	0	0	0	0	0	0	0
20...	...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21...	...	0	0	0	0	0	0	0	0								
22...	...	0	0	0	0	0	0	...	0	0	0	0	0	0	0	0	0
23...	...	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
24...	...	...	0	0	0	0	0	0	0	0	0	0	0	N 12	0	0	0

Parthenogenesis in Ants.

Although the workers rarely lay eggs, still they do so occasionally, among ants as well as among bees and wasps. In the two latter groups these virgin eggs always produce drones; and the same will probably be found to be the case with ants also. I have a nest of *Formica cinerea* which I brought from Castellamare in December 1875, and which has no queen: nevertheless eggs were laid in it last spring, and these eggs produced winged individuals only, all, I believe, males; but unfortunately they emerged one day when I was away from home, and I lost the opportunity of examining them carefully. None of the eggs, however, produced workers.

Parasites of, and on, Ants.

The curious blind Woodlouse (*Platyarthrus Hoffmanseggii*) is very common in ants' nests in my neighbourhood. I have, however, never seen the ants take the slightest notice of them. Moreover, when my ants migrate from one nest to another, if the nests are at a little distance apart, the *Platyarthri* remain behind. I am disposed to think that they are mere scavengers.

On the 14th of October I observed that one of my ants had a mite attached to the underside of its head. The mite was almost as large as the head, and must have been very inconvenient. The ant could not remove it herself. She never came out of the nest, so that I could not do it for her; and none of her own companions from that day to this (1 Feb.) have thought of performing this kind office. I have also observed specimens of a minute red Mite, which I believe to be new, in nests of *Lasius flavus*.

Certain species of Diptera, belonging to the family Phoridæ, are also parasitic on ants. I have forwarded them to Mr. Verral, who finds that some of them are a new species of the genus *Phora* and that among them is also the type of a new genus, which he proposes to call *Platyphora*, doing me the honour of naming the species after me. I subjoin his descriptions as a separate paper or appendix to my own.

In conclusion I wish to acknowledge the valuable assistance which I have received from my wife and daughters and their governess, Miss Wendland. Without their aid I could not have carried out the continuous observations above recorded.

Having had some enlarged drawings made, for my own convenience, of several specimens of the ants which I had been

watching, it was suggested to me that figures of these same, though not new to entomologists, might nevertheless be desirable to those interested in the subject. In the Plate each figure is considerably enlarged, but the actual dimension is expressed by scale alongside.

EXPLANATION OF PLATE XVII.

Fig. 1. *Polyergus rufescens.*
2. *Formica sanguinea.*
3. —— *fusca.*

Fig. 4. *Atta barbara* (worker major).
5. Do. (worker minor)
6. *Strongylognathus testaceus.*

Description of a new Genus and Species of Phoridæ parasitic on Ants. By G. H. Verral, Esq., Memb. Entom. Soc. Communicated by Sir John Lubbock, Bart., F.L.S., &c.

[Read February 1, 1877.]

Through my friend Mr. Frederick Smith, of the British Museum, Sir John Lubbock has kindly forwarded for my examination and determination certain specimens of Dipterous insects said to have been found parasitic on species of ants, which latter he has been studying with care as to their habits. Having given considerable attention to the family Phoridæ, I was agreeably surprised to find the parasitic specimens to be forms new to science. One of these is a new species of the genus *Phora*; the other I regard as possessing characters *sui generis*, and hence define it under the generic title *Platyphora*, at the same time bestowing on the species the name of the discoverer, who worthily pursues entomological researches, spite of many pressing public engagements.

The subjoined descriptions embrace the diagnostic peculiarities of the insects in question.

Phora formicarum, n. sp. Nigro-cinerea, fronte setosa, caniculata; antennis mediocribus, cinereis; palpis magnis, flavis; halteribus flavidis; pedibus totis pallide flavis, inermibus, tibiis intermediis unicalcaratis, posticis modice dilatatis; alis subhyalinis, nervo secundo simplici, nervulis vix undulatis. Long. vix $\frac{1}{2}$ lin.

Frons broad, grey, bristly, two large bristles being close to the eye-margin; down the centre is a deep impressed channel, which at its lower

end joins a channel above the antennæ, and at its upper end a channel round the raised vertical triangle; the space between these two latter channels (comprising the true *frons*) is about once and a half broader than deep; on the vertical triangle are two bristles; the third joint of the antennæ is moderately large, ovate, grey; the arista short, somewhat yellowish, almost naked; the palpi conspicuous, all pale yellow, with a few short black bristles at the tip; on the cheeks are some short black bristles.

The thorax is grey or brownish grey, broad, not much arched, the disk being nearly flat, and on the hinder part absolutely concave; on the disk there are no long bristles, but a dense clothing of rather short, black bristles; along the side of the thorax between the humeri, the base of the wing, and the scutellum are some long black bristles, and two on the thorax just before the scutellum; on each side of the scutellum are two long bristles; halteres dirty pale yellow; abdomen bare, dull black, with slightly yellowish incisures; ovipositor polished black, long, slightly incurved and grooved.

Legs pale yellow, including the coxæ, clothed with minute black bristles; all the coxæ with two or three black bristles at the tips, the legs otherwise bare excepting the spurs; femora flattened and widened, especially the hind pair, the hind tibiæ also slightly flattened and widened on the apical half; middle tibiæ with a long spur inside at the tip, and hind tibiæ with a small one inside and a very minute one outside; tarsi longer than the tibiæ, joints gradually diminishing in length.

Wings very slightly smoky, broad; second thick vein not extending half the length of the wing, thickened, but not forked at its tip; first veinlet with a steady curve; second very slightly curved at base, otherwise straight; third very slightly undulated; fourth hardly visible at base, evident towards tip, very slightly undulated; costa bristly up to end of second thick vein.

This species is readily distinguished by its simple second thick vein, channelled frons, small size, and by the absence of bristles on the tibiæ.

It is parasitic on *Lasius niger*.

Platyphora, n. gen.

Lata, plana, tota absque setis. Frons latissima. Thorax transversus. Abdomen parvus. Alarum vena cubitalis simplex, subcostali parallela; venulæ undulatæ; costa ad basin subciliata.

Distinguished from all the existing genera of Phoridæ by its flat and broad shape, which resembles that of the small species of *Sphærocera*. The absence of strong bristles on the frons, thorax,

and legs also distinguishes it from all the genera except *Gymnophora*, which, however, is of the usual arched *Phora*-shape and has the cubital vein forked, costa bare, &c.

PLATYPHORA LUBBOCKII. Nigra, nitida; abdomine triangulari, segmento tertio parvo; femoribus posticis basi flavidis; alis apice latis, flavido-hyalinis, costa ad basin subciliata, vena cubitali ad medium costæ extensa subcostali parallela, venulis undulatis. Long. $\frac{3}{4}$ lin.

Broad, flat, shining; frons very broad, the eyes scarcely occupying each one sixth the width of the head; it is moderately shining, gently arched, and pretty densely clothed with minute bristles; the three ocelli visible slightly luteous; antennæ with the third joint rather large, somewhat rounded; thorax broad, flat, rather broader than the head, angles tolerably rounded, disk shining (in appearance suggesting a small *Sphærocera*), beset with very minute bristles, which become rather scarcer towards the hinder part; scutellum rather dull, margined, nearly four times as broad as long: abdomen black, narrower and shorter than the thorax (again suggestive of *Sphærocera*); each segment after the second successively narrower, the last one being almost triangular; the third segment is very short, contracted under the second; the hind margins form a curve convex towards the thorax, the first segment being slightly emarginate in the middle; the sixth (last) is much the longest. Legs stoutish, blackish, basal two thirds of hind femora yellowish; middle tibiæ with two small spines at the tip. Wings considerably overlapping the abdomen, yellowish hyaline, darker about the basal half of the costa, blunt at the tip, cubital vein extending about half the length of the wing, and the costa slightly ciliate up to its end, subcostal vein running parallel to it and ending just before it; both veins a little thickened at their ends; first veinlet curved S-like, considerably at its base, slightly at its end, vanishing distinctly before the tip of the wing; second veinlet also S-like, diverging at its end from the first, and ending distinctly below the tip of the wing; third veinlet slightly undulated, ending very wide from the second; fourth faint, not reaching the end of the wing.

This description having been made from a specimen gummed down on card, though in very good condition, I am unable to decide on the sex, or to examine the face, palpi, base of antennæ, or coxæ.

The Anniversary Address of the President,

Professor Allman, M.D., LL.D., F.R.S.

[Read May 24, 1876.]

Recent Researches among some of the more simple Sarcode Organisms.

When addressing you last year in fulfilment of the duty which annually devolves on your President, I believed that the object intended to be gained by this custom would be best carried out by making the Address as nearly as possible an exponent of recent progress in some special field of biological research.

I then selected for our subject the group of the true or ciliate Infusoria, and endeavoured to lay before you the principal steps by which our knowledge of these minute organisms had been recently advanced.

Guided on the present occasion by the same principle, I shall endeavour to treat in a similar way certain other groups in whose investigation much activity has shown itself within the last few years—simple sarcodic organisms, among which are, indeed, the simplest which it is possible to conceive—beings whose very simplicity give them a significance which can scarcely be overestimated in our investigations of the phenomena of life.

The limits, however, which must of necessity be imposed on the length of such an address render it impossible to treat the subject in all the details which an exhaustive exposition would involve. Much therefore, especially such as belongs to the description of special forms, must be omitted from our review; and I shall confine myself mainly to the results of observations which have made us acquainted with such forms and phenomena as have a more or less direct significance in their relation to morphological types and their bearing on physiological laws.

Most of the organisms which I propose to bring under review have probably their nearest relations with the animal rather than with the plant; but it must not be forgotten that the distinction is in many cases arbitrary, and that we have often no reliable character which will enable us to assert that the scarcely differentiated particle of protoplasm before us belongs to the animal kingdom rather than to the vegetable, or to the vegetable rather than to the animal.

This difficulty has been fully recognized by Haeckel, who has

included the whole of the organisms we are here about to consider in his group of Protista, which he regards as composed of beings which are neither animals nor plants, and which thus form a third organic kingdom equivalent to the animal kingdom on one side, and to the vegetable on the other.

The advances which have of late years been made in our knowledge of the lowest forms of living beings are largely due to the important reform introduced by Max Schultze into the theory of the cell, when, by his researches on the Monothalamian Rhizopod *Cornuspira**, the old conception of the cell as a membranous sac with contents gave place to the doctrine that in its original condition the cell represents only a naked lump of protoplasm with an imbedded nucleus; and this doctrine gained further significance when he insisted on the fact, of fundamental importance in Biology, that the soft substance of the Rhizopoda, to which Dujardin had given the name of sarcode, was identical with the cell protoplasm of all higher animals and plants.

It was further shown by Haeckel † that there exists a great number of the lowest organisms whose structure is even simpler than had been imagined by Max Schultze; for in their naked protoplasmic bodies there is never to be found at any period of their lives a trace of a nucleus. He regards the nucleus as an essential constituent of the genuine "cell," which he views as the more highly developed elementary organism, and which ought to be carefully distinguished from the lower homogeneous, non-nucleated protoplasm mass, for which he proposes the name of "Cytode."

Both these forms of elementary organisms (the cell and the cytode) he embraces under the name of "Plastid," as being the builders-up of all complex organisms.

He regards this distinction of the two kinds of plastids as of the greatest importance in its bearing on the phylogenetic or genealogical history of organisms, since it is only such absolutely simple organisms as cytodes that can originate by spontaneous generation (*Urzeugung*), while it is only later on in the course of the development that cells become evolved from the cytodes by differentiation of an inner nucleus and an outer protoplasm.

In the greatest number of organisms the individuals take their

* "Ueber *Cornuspira*," Archiv für Naturg. 1860.

† 'Generelle Morphologie;' and "Beiträge zur Plastidentheorie," Jenaische Zeitschr. vol. v.

origin from nucleated cells, whether eggs or spores; and in these, as insisted on by Haeckel, genuine cytodes cannot occur. Here all the later plastids which compose them must have arisen from the genuine cell and, like this, must have been originally nucleated. If non-nucleated plastids, such as the red blood-corpuscles of Mammalia, should show themselves, these must have been produced by retrogradation—a loss of the nucleus in what was originally a genuine nucleated cell. In order to distinguish them from the true non-nucleated cytode, he gives them the designation of "Dyscytodes."

Among the forms which I am now about to bring before you, many examples of both true cells and cytodes will have to be adduced.

Hertwig and Lesser* have described a number of low *Amœba*-like organisms and of other rhizopodous forms of fresh water. They have worked out with much care their structure and affinities, and have attempted a general exposition of their organization and systematic position.

They all consist of masses of protoplasm in which a nucleus with nucleolus are almost always developed, and which, besides these, include a greater or smaller number of vacuoles, which may be either contractile or non-contractile. In the more purely amœboid forms their bodies have no definite shape, and are, for the most part, absolutely naked; but they are occasionally enveloped for a greater or less extent in a thin pellicle, which is excreted from the surface of the protoplasm, and follows all its changes of form, while, in rare cases, they are covered by foreign particles agglutinated together. In others, however (*Monothalamia*, Hert. & Less., and *Heliozoa*), there exist more definite protective structures either in the form of external hard shells or of firm membranous cases, or of variously arranged spines and spicules.

In morphological value none of them pass beyond the stage of a simple cell, or, at most, of two or more cells fused together into a single protoplasm-mass without any tendency to the formation of tissues or the differentiation of organs. In the protoplasm, however, may frequently be distinguished two layers or zones—an external layer (ectosarc), clearer and more homogeneous, and an internal layer (endosarc), less transparent and more loaded with granules. These two layers, for the most part, pass gradually into one another.

* "Ueber Rhizopoden und denselben nahestehende Organismen," Arch. f. mikr. Anat. vol. x. Suppl. 1874.

Hertwig and Lesser have paid especial attention to the structure of the nucleus, and have shown that in it and its contained nucleolus there is a remarkable constancy of character. The nucleus presents the appearance of a clear vesicle whose contents are either sparingly or not at all coagulable by acetic acid; while the nucleolus which it encloses is either a simple oval pale bluish body, or appears to have been broken up into several such bodies; it becomes granular in weak acetic acid, and in stronger acid swells up without becoming dissolved. In some cases the nucleus is seen to be bounded by a delicate structureless membrane-like layer (nucleus membrane), though in others no definite boundary layer can be demonstrated.

The same authors have distinguished in these organisms two kinds of locomotion. In one the contractility of the protoplasm affects equally the whole mass; the body changes but slightly its contour, and glides over the supporting object by a constant rotation of its whole surface, as is seen in *Hyalodiscus*, Hert. & Les. In the other, which is by far the more frequent condition, locomotion is effected by the contractility of limited portions of the surface, either causing the protrusion and retraction of blunt or pointed pseudopodia by means of which the organism is pushed or drawn forwards, or giving rise to a streaming forth of the protoplasm by which the whole body seems, as it were, to flow forward in a definite direction.

There is no definite orifice for the ingestion of nutriment, which gains access to the interior of the body solely by transmission through the surface of any part of the protoplasm which may be exposed to the surrounding medium. Solid nutritious matter thus becomes pressed into the deeper parts of the body, where during assimilation it may generally be seen accumulated in pellets surrounded by a clear liquid and included in a simple vacuole, from which the effete residue becomes afterwards expelled, and is finally ejected through any part of the exposed surface of the protoplasm. The attempt to confine the process of assimilation to the endosarc and of contractility to the ectosarc is not supported by careful observation. Indeed the absence of specialization in this most generalized phase of nutrition is further apparent from the fact that the whole process may take place even in a pseudopodium.

In almost every case, as already said, vacuoles occur distributed through the protoplasm. These are filled with a clear liquid, and are either variable in number and indefinite in position, or they

occupy a definite position and are then also definite in number. They mostly appear and disappear at intervals; and in those vacuoles which have a definite number and fixed position the appearance and disappearance follow one another at equal intervals, having thus a regularly rhythmical sequence. It is not easy, however, by any hard and fast line to separate these two classes of vacuoles from one another; even those with indefinite position and number sometimes show a rhythmical contraction, while they all pass by intermediate conditions into those irregular liquid-holding spaces so obvious in the protoplasm of plant-cells. It is these conditions which have induced Hertwig and Lesser, in opposition to the views of other zoologists, to assign little or no systematic value to the contractility of the vacuoles.

As may be expected in organisms of such extremely simple structure and with the functions of nutrition and irritability showing such little tendency to specialization, there is a corresponding simplicity in the function of reproduction. This, indeed, is probably limited to a simple division of the body referable to the established laws of cell-multiplication; for the assumption that the nucleus exercises a sexual function, though insisted on by some observers, does not rest on a sufficient number of continuous and connected observations.

In many cases, however, an encysting process becomes introduced into this simple form of reproduction. The organism withdraws its pseudopodia, secretes around it a membranous cyst, and passes into a resting state. Within the cyst the protoplasm divides into two or more portions, and these finally break through the walls of the cyst and become free.

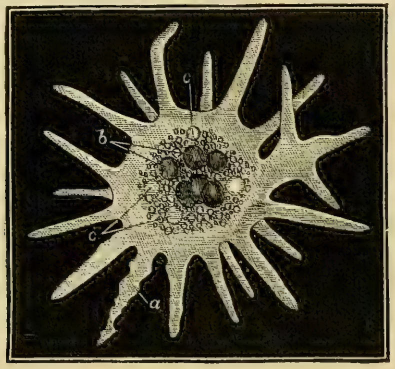
Hertwig and Lesser regard this intercalation of an encysting process into the development-cycle of the organism as conditioned by the laws of adaptation with inheritance. Many observed phenomena tend to show that the encysting at first arose from an adaptation to external conditions, and only at a subsequent period became subservient to reproduction. They suggest that it may have served originally either in maintaining the vitality of the organism during the drying up of the pools of water inhabited by it, or in affording a protection from its enemies when, after abundant ingestion of nutriment, it passes for the purposes of digestion into a quiescent state.

The organisms distinguished by the characters here enumerated, together with certain marine forms—the so-called Foraminifera—to which the present review is not intended to extend, correspond

very nearly to the *Rhizopoda* with the limits assigned to this group by Max Schultze. Hertwig and Lesser, however, substitute for the designation Rhizopoda in the Schultzian sense that of *Sarcodina,* and confine the former to one of the sections into which they have divided their group of the *Monothalamia.*

From these general remarks we may now pass to the more important special forms to which the attention of zoologists has been recently directed.

Fig. 1.



Dactylosphærium vitreum. *a*, pseudopodium in the act of withdrawal; *b*, food-pellets; *c c*, non-contractile vacuoles. (After Hertwig and Lesser.)

Under the name of *Dactylosphærium vitreum* (fig. 1), Hertwig and Lesser describe a freshwater rhizopod which but slightly differs from *Amœba.* It has a roundish body composed of homogeneous hyaline protoplasm with a multitude of yellow or green strongly refringent granules, which fill the whole of the interior of the body as far as a narrow hyaline margin. The pseudopodia are blunt finger-shaped processes which radiate in all directions from the surface, and consist of a perfectly homogeneous hyaline protoplasm.

The mode in which the pseudopodia are withdrawn is peculiar. When one of these is about to disappear, it seems suddenly to change its form; its smooth surface becomes nodular and irregularly sinuous, it conveys the impression of having suddenly lost its turgescence, and then it rapidly flows back into the body.

Numerous non-contractile vacuoles exist; but the multitude of coloured corpuscles so interfered with the transparency of the protoplasm, that it was impossible to decide with certainty as to the presence of a nucleus.

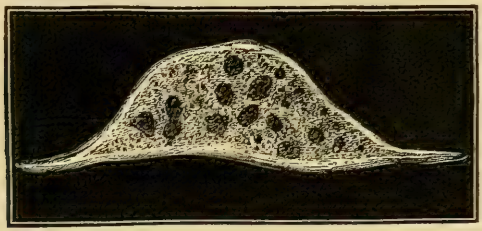
In a variety in which the yellow corpuscles are replaced by

green, the whole, or part, of the surface is seen to be in most cases covered with fine villi-like processes, a condition very similar to one which has been frequently described as occurring in *Amœba.*

Towards the centre of the protoplasm were numerous pellets composed of foreign matter, evidently the remains of nutriment derived from plants and ingested as in other amœboid organisms.

Hyalodiscus rubicundus (fig. 2) is another form described by Hertwig and Lesser. It differs from all known sarcode animals in its peculiar mode of locomotion; for while, in all other Rhizopoda, locomotion is effected by variously formed pseudopodia, by which the organism is pushed or pulled forwards, or by means of an apparent pouring forth of a stream of protoplasm, by which it, as it were, flows over the subjacent objects, in *Hyalodiscus* all parts of the surface contribute equally to the locomotion, and it is only the direction in which all the individual parts of the surface move that determines the line in which the organism glides forwards.

Fig. 2.



Hyalodiscus rubicundus. The animal in the act of creeping, viewed laterally. (After Hertwig and Lesser.)

The form of *Hyalodiscus rubicundus* is that of a disk flattened on one side, convex on the opposite. Its body consists of a homogeneous, colourless, and hyaline external layer (ectosarc), and a granular central mass (endosarc), which is loaded with brownish red corpuscles. In the middle of the endosarc is a nucleus, and towards its periphery numerous vacuoles; but whether these are or are not contractile could not be determined.

Though the *Hyalodiscus* moves with considerable velocity over the stage of the microscope, scarcely any change of shape can be observed in it—a feature in which it strongly contrasts with the protean changes of an *Amœba.* During the progression of *Hyalodiscus*

every point of the surface may, under the microscope, be seen to be in a constant rotation; so that on the dorsal side of the animal (that turned away from the supporting surface) each point travels from behind forwards, while on the ventral side it travels from before backwards, thus causing, by friction against the surface of support, a rolling forwards of the entire animal. This rotation of the superficial particles of the sarcode body is rendered apparent by watching the movements of minute foreign bodies which happen to be adherent at the surface.

It is not, however, in the external layer alone, but in the whole body, that motion of rotation exists. The coloured corpuscles and granules of the endosarc may be seen to be constantly moving in a forward direction on the dorsal side, and in the opposite direction on the ventral side, so that every one of them describes a complete circle. Even the nucleus participates in the general rotation of the particles, though from its nearly central position the circle in which it rotates is a small one.

This interesting form of protoplasm motion can be explained, as Hertwig and Lesser remark, only by attributing to every point of the body, as well as of the endosarc as of the ectosarc, a nearly uniform contractility, such as Max Schultze assumes in order to explain protoplasm-currents in general.

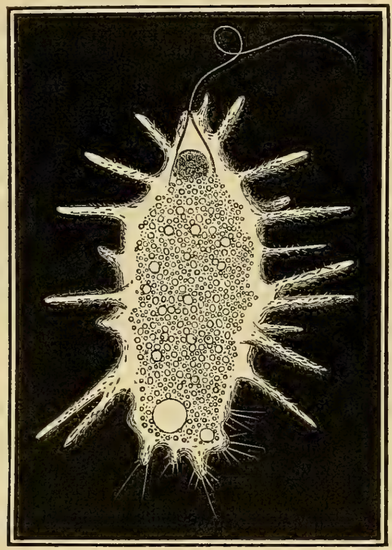
Hertwig and Lesser have not witnessed the actual ingestion of nutriment, though abundant nutriment-masses were seen imbedded in the endosarc, where they lay without being surrounded by any distinct vacuole.

A remarkable amœboid organism, which forms in some respects a transition form between the *Amœbæ* and the *Flagellata*, has, under the name of *Mastigamœba aspera* (fig. 3), been described by Franz Eilhard Schulze*, who discovered it in a pond of the Botanic Garden at Grätz. Like other amœboids it is very changeable in shape; but its usual form is that of an appressed oval, from whose sides simple, blunt, finger-shaped pseudopodia are given off. One end is more pointed than the opposite, and from the pointed end, which during locomotion is always turned forward, there projects a long, very fine, non-retractile, cylindrical filament of sarcode, in all respects resembling a flagellum of the true *Flagellata*. The regularly disposed lateral pseudopodia, and the position of the flagellum at the end of the long axis, give to the creature a superficial resemblance to a bilateral animal,

* F. E. Schulze, "Rhizopodenstudien," Arch. f. mikr. Anat. vol. xi. p. 583.

creeping by means of the appendages situated along the sides of its body.

Fig. 3.



Mastigamœba aspera, as seen when creeping over the field of the microscope. (After F. E. Schulze.)

In the body may be distinguished a strongly refringent, hyaline, colourless ectosarc, from which the pseudopodia directly proceed, and a softer endosarc loaded with clear reddish yellow spherules and colourless granules, and usually containing also the masses of ingested nutriment. The greater part of the external surface is beset with very minute, refringent, rod-like structures, compared by the author to certain *Bacteria* (*Bacteria termo*). These usually lie tangentially to the surface, to which they give a peculiar roughness, which has suggested the specific name. During the act of creeping the posterior pseudopodia are usually reduced to the condition of short thick processes, from which may be seen radiating extremely fine sarcode projections, quite like the fine processes observed on the hinder end of certain *Amœbæ* (*Amœba princeps*), where they give a kind of flocculent appearance to the surface. The endosarc at the boundary between it and the ectosarc contains one or two vacuoles, which always lie at the hinder end and alternately appear and disappear, without, however, showing any distinctly rhythmical pulsation.

At the anterior end of the animal, just below the root of the flagellum, and at the boundary between endosarc and ectosarc, there is imbedded in the endosarc a roundish, smooth, rather strongly refringent body, whose significance has not been determined. It projects beyond the boundary of the endosarc, and appears to be surrounded by a clear area, which separates it by a considerable space from the ectosarc, and by a much narrower space from the endosarc in which it is imbedded. This area is extended forward in a point reaching the surface of the body close to the root of the flagellum; but whether it communicates here with the exterior could not be determined. The body thus enclosed within the clear area shows in its interior a great number of sharply defined, spherical, clear corpuscles; and it can slowly but distinctly change its shape, appearing at one time oval, then quite spherical, then more irregular with rounded angles—characters which the author considers incompatible with the supposition of its being either a nucleus or a nucleolus, in the latter case with the surrounding clear area representing the body of the nucleus.

The liability, however, of the nucleus or nucleolus to changes of form ought not to surprise us. Hanstein has shown the occurrence of amœboid changes of form in the nucleus of a great number of plant-cells*; Alexander Brandt has demonstrated similar changes in the nucleolus of the egg in *Blatta*†; and Eimer has shown that the germinal spot (nucleolus) in the egg of the *Silurus glanis* and that of the Carp exhibits amœboid changes like those of the colourless blood-corpuscles‡.

Under the name of *Plakopus ruber* (fig. 4), F. E. Schulze § describes an amœboid rhizopod, which is rendered very remarkable by the peculiar condition of its pseudopodia. These are in the form of thin membranes, which may extend themselves over the surface of other bodies or project free into the surrounding water. They form either a single very thin plate which spreads over the supporting body, or they consist of several lamellæ which unite with

* Botanische Zeitung, 1872.

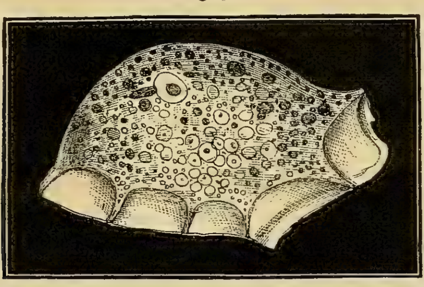
† "Ueber active Formveränderungen des Kernkörperchens," Arch. für mikr. Anat. vol. x. p. 505.

‡ "Ueber amöboide Bewegungen des Kernkörperchens," Arch. für mikr. Anat. vol. xi. 1875.

§ Arch. f. mikr. Anat. vol. xi. 1875.

one another at different angles so as to enclose funnel-shaped cavities with their mouths turned outwards.

Fig. 4.



Plakopus ruber, with its membranous pseudopodia enclosing cup-shaped cavities; multitudes of vermilion-coloured corpuscles scattered through its protoplasm. (After F. E. Schulze.)

The body is differentiated into a hyaline, refringent, cortical layer, from which the pseudopodia are formed, and an internal parenchyma in which granules, usually of a cinnabar or brick-red colour, though occasionally green, are imbedded.

The parenchyma contains also one or more nuclei, whose position changes, as in the true *Amœba*, with the movements of the animal. The nucleus encloses a relatively large nucleolus.

Finally round vacuoles in variable number and of different sizes are scattered through the parenchyma, and may sometimes be seen to have passed into the pseudopodia. Their pulsation is not always manifest.

Schulze has not succeeded in demonstrating any decided fact regarding the reproduction of this curious rhizopod.

Greeff gives the name of *Pelomyxa palustris* (fig. 5) to an amœboid organism which he discovered spreading over the bottom of stagnant pools, first in the neighbourhood of Bonn and afterwards at Marburg*. It isusually in the condition of little, slimy, blackish sarcode masses, which may attain a diameter of even two millimetres. It is capable of great change of shape during its active amœboid movements, which are effected by the extension of its periphery into thick lobes or hemispherical projections, or by continued undulations of its surface.

* Arch. f. mikr. Anat. vol. x. 1874. The name of *Pelobius*, which he had first assigned to it, had been already given to an aquatic beetle, and was therefore changed by Greeff into *Pelomyxa*.

The substance of its body is differentiated into an outer cortical layer of homogeneous hyaline sarcode and an inner parenchyma loaded with spherical vacuoles, which give it a vesicular or frothy appearance. Its dark colour is due to foreign matter taken in as nutriment; and specimens from Rostock, since described by Fr. Eil. Schulze*, were colourless.

Besides the vacuoles there occur in the parenchyma a great number of nucleus-like bodies, as well as of peculiar globular, hyaline, and brilliant bodies, to which Greeff gives the name of "Glanzkörper," and of minute rod-like structures.

The nucleus-like bodies are very numerous, some hundreds being visible in a single specimen of ordinary size. They enclose hyaline contents with minute dark granules, which lie against their walls. In some of them, instead of the minute granules, several larger bodies like nucleoli make their appearance. These increase in size, become excavated by a cavity, and finally occupy the whole interior of the apparent nucleus, which now bursts and sets them free into the surrounding parenchyma. Greeff believes that after becoming free they are transformed into the hyaline homogeneous bodies (*Glanzkörper*).

These last exist in great numbers, and give to *Pelomyxa* a very characteristic appearance. They are for the most part of a globular form, and consist of a firm glistening capsule with mostly hyaline and homogeneous contents. They multiply by division in the interior of the *Pelomyxa*. Sometimes the contents were seen to have become retracted from the wall of the capsule and to assume an amœboid outline; but Greeff was unable to follow them through further changes.

He, however, records an observation which, if it be not referable to a case of parasitism, would seem to throw light on the reproduction of *Pelomyxa*. While watching under the microscope an old and apparently dead specimen of *Pelomyxa*, he saw suddenly break forth from its surface a multitude of minute amœbiform bodies, each with a nucleus and contractile vacuole. After exhibiting for some time active amœboid movements, they became more sluggish, withdrew their pseudopodia, assumed the form of spherical or pyriform bodies, and passed into a resting state. From these a long vibratile filament was subsequently developed, and the *Amœbæ* became thus changed into active swimming Flagellates. Their further destiny Greeff did not succeed in disco-

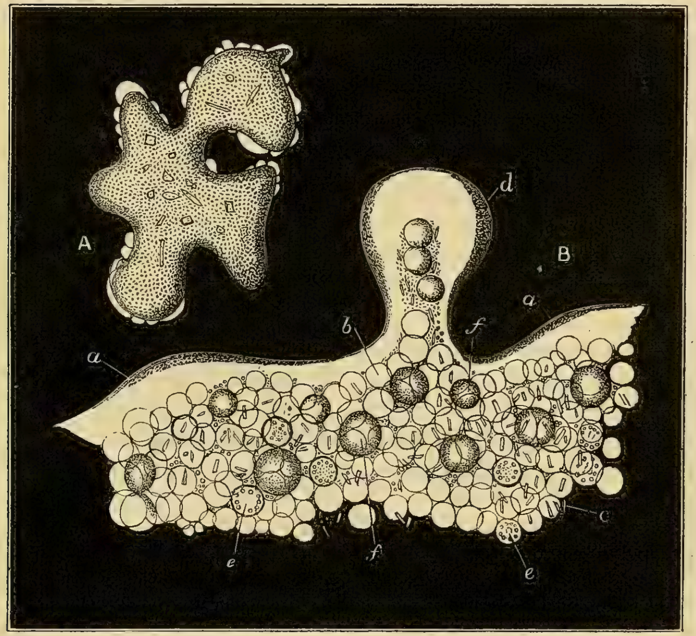
* "Rhizopodenstudien," Arch f. mikr. Anat. vol. xi.

vering; but he believes that the amœboid brood is directly derived from the hyaline bodies, which he regards as the germs or spores of the *Pelomyxa*.

The only form of reproduction observed by F. E. Schulze in *Pelomyxa* was a division of the whole body*.

The rods are scattered in great numbers in the parenchyma. They are composed of an organic substance; but Greeff was not able to determine any thing as to their origin or significance.

Fig. 5.



Pelomyxa palustris. A, the entire rhizopod as it appears when in active amœboid motion. B, a portion more highly magnified: *a a*, the hyaline ectosarc thrown into prominent undulations; *b*, one of the vacuoles of the endosarc; *d*, protruded mass of the hyaline ectosarc; *e e*, nuclei; *f f*, globular hyaline homogeneous bodies (*Glanzkörper*). Numerous rod-like bodies (*c*) are seen scattered through the endosarc. (After Greeff.)

We owe to Greeff some very interesting observations showing that the *Amœbæ*, a group of organisms which had been hitherto sup-

* F. E. Schulze, *loc. cit.*

posed to be exclusively aquatic, have terrestrial representatives*. The *Amœba terricola* of Greeff occurs in earth and dry sand. It has an irregularly spherical form, with blunt nodular projections and a dull glassy appearance. It looks like an irregularly shaped fragment of silica, and might be easily passed by as a grain of sand.

A more careful examination shows within it yellow granules, which are in lively motion, streaming here and there through the soft protoplasm.

Its body is composed of two substances, an outer hyaline layer of firmer, consistence, and an inner granular, softer, and more fluid parenchyma. Nowhere among the aquatic *Amœbæ* is the difference between these two constituents so strongly defined as here. The hyaline outer layer is the chief source of the contractility.

The motions of the animal are peculiar and different from those of the aquatic *Amœbæ*. It does not, like these, appear to flow over the surface on which it lies, but raises itself on the projections from its body, which, unlike the pseudopodia of the aquatic *Amœbæ*, are firm and strong enough to support it. While thus balanced, the influx of the granular parenchyma towards certain parts of the periphery disturbs the equilibrium and causes the whole to roll over. Its motion is thus a rolling instead of a creeping one. In some cases the peculiar villous condition first noticed by Wallich and Carter in certain aquatic *Amœbæ* was present on the posterior end of the body.

No special membrane is to be found on the outer layer; and Greeff, in opposition to Auerbach, denies the presence of such a membrane, not merely on his terrestrial *Amœba*, but on the aquatic ones.

A number of clear vacuoles of different sizes may be seen floating in the soft parenchyma. These are very variable in size and number. They are carried about by the currents, and may be seen in one and the same individual to change from minute to minute. When two vacuoles come in contact they frequently run together into a single one, which may still further combine with others. Occasionally one of the large vacuoles may be seen to approach the periphery of the parenchyma and then suddenly disappear as if it had been emptied outwards. After a few seconds, however, we find in its place a great number of very small vacuoles, which again gradually unite with one another until, instead of a

* "Ueber einige in der Erde lebenden Amœben" &c., Arch. f. mikr. Anat. vol. ii. 1866.

multitude of small vacuoles, we have once more a single large one.

Small algæ, diatoms, and other foreign bodies are also found imbedded in the parenchyma. These have been taken in as nutriment, and are frequently found enveloped by the yellow bodies already referred to. Greeff regards these yellow bodies, which are also frequently present in the aquatic *Amœbæ*, as intended to promote the digestion of the ingested nutriment; and he compares them with the so-called liver-cells, also of a yellowish colour, which clothe the digestive canal in many of the lower animals—an analogy which at best may be regarded as very remote.

Among the contents of the body occur also minute crystalline-looking structures, which, however, are without any definite form. Greeff has no doubt that they are a product of the *Amœba* itself, and not introduced from without. Similar bodies are known to occur in aquatic *Amœbæ* and other Rhizopoda, where they have been described by Auerbach, Wallich, Carter, and others.

But the most important structure found in the inner parenchyma is the nucleus. Like many of the other bodies which are found there, it is carried about by the sarcode currents, and is so soft that it changes its shape when it meets with any obstruction in its course. It is enveloped in a double membrane. It is viewed by Greeff as an organ of reproduction. It consists at first of a homogeneous protoplasm with some dark glistening granules; but after a time the entire nucleus becomes filled with solid round corpuscles, which he regards as the young progeny of the *Amœba*. The outer covering then disappears, and he believes that the solid corpuscles escape into the surrounding parenchyma. The whole of the nucleus thus becomes broken up into the young brood which fills the body of the *Amœba*. The *Amœba* now ceases to take in food, its motions become less active, and its functions seem to be entirely confined to the protection and development of the young. These are soon ejected, and become developed externally into the form of the parent. Greeff has found such young *Amœbæ* in the surrounding sand.

In two instances Greeff observed in the interior of the body elongated soft masses apparently composed of bundles of sinuous hair-like filaments, which recalled the supposed spermatic filaments described by Balbiani in the so-called nucleolus of the Infusoria;

but his observations were not sufficiently complete to justify him in maintaining their actual analogy with these bodies.

In connexion with Greeff's observations on the relations of the nucleus to reproduction in *Amœba terricola*, may be here mentioned those of Fr. Eil. Schulze on the behaviour of this body in the multiplication of *A. polypodia*, Max Schultze. F. E. Schulze* has seen the nucleus with its nucleolus in this rhizopod divide by a transverse constriction; the two halves recede from one another, and the body of the *Amœba* then, by a similar constriction, divides between the two segments of the original nucleus. The process in this case thus differs essentially from that described by Greeff, and corresponds to a well-known form of cell-multiplication.

The *Amœba terricola* occurs, according to Greeff, very frequently in sand and in the earth on the root-fibres of mosses, grasses, and other plants when they do not form too thick a layer on the surface of rocks, walls, house-tops, trunks of trees, and the like. It is almost always found in company with terrestrial Arctiscoida (" bear animalcules "), Rotifers, Anguillulæ, &c.

The shallow layer of earth in which it lives frequently exposes it to desiccation, when its vital activity is arrested. In this condition the firm hyaline outer layer contracts more and more with the increasing dryness, and thus affords to the soft granular parenchyma a protection against absolute desiccation. When moistened, however, with water, it once more awakens to complete activity even after a dormancy of many months.

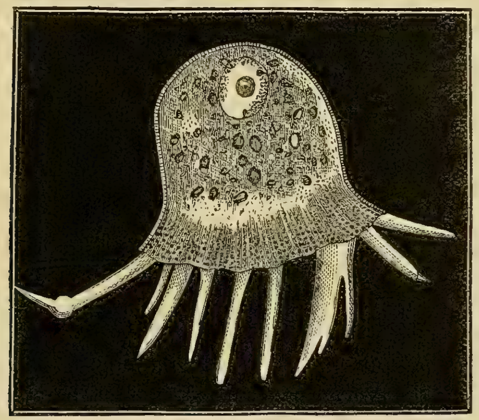
Among the terrestrial amœbiform organisms discovered by Greeff is one which he assigns to a new genus under the name of *Amphizonella*. He distinguishes three species, of which one, *A. violacea*, has been especially observed by him. The *Amphizonellæ* are distinguished from the *Amœbæ* by being provided with an external soft capsule, which is quite distinct from the proper cortical layer. They have a large round nucleus; and pseudopodia, which rapidly appear and disappear, are emitted from the interior and bore their way through the external capsule, which again, on their withdrawal, becomes so completely closed as to lose all trace of having been perforated. In *A. violacea* the internal protoplasm is of a beautiful violet colour. Greeff has witnessed a partial fusion of two individuals. He regards this as a case of conjugation, and believes that it is followed by the formation of a young brood within the body of the parents.

* Arch. f. mikr. Anat. vol. xi. p. 592.

Some other forms have been described by Archer* as species of *Amphizonella*, but which, unlike the terrestrial species discovered by Greeff, are inhabitants of fresh water. The *A. vestita* of Archer, however, is, as shown by Hertwig and Lesser, not referable to Greeff's *Amphizonella*, and is regarded by these observers as identical with their own *Cochliopodium pellucidum*. They rectify Archer's description, and point out the causes of error by which he was deceived in his attempts at identification.

The complete disappearance in the different species of *Amphizonella* of the apertures caused by the pseudopodia in boring their way through the outer coat reminds us vividly of the phenomena which have been proved to accompany the migration of the blood-corpuscles through the coats of the capillaries in the higher animals.

Fig. 6.



Cochliopodium pellucidum, viewed from the side, with widely open test-orifice, through which numerous pseudopodia are projected. (After F. E. Schulze.)

Hertwig and Lesser† describe, under the name of *Cochliopodium pellucidum* (fig. 6), a very interesting Rhizopod which they found in great quantity in ditches at Reinhardsbrunnen and in a pond in the Botanic Gardens at Bonn. They have identified it with Archer's spineless variety of *Amphizonella vestita*, which they regard as having nothing which would justify a subordination of it to Greeff's genus *Amphizonella*.

It consists of a nucleus-bearing protoplasm body which, not-

* Quart. Journ. Micr. Sci. vol. xi. 1871. † *Loc. cit.*

withstanding its being enveloped in a closely applied test, is subjected to all the protean changes of form which are so characteristic of the naked sarcode animals.

The test is quite colourless, and possesses an areolar structure like that of the shell of *Arcella*, from which, however, it differs in its much greater delicacy and in its flexibility and want of definite form. It possesses great extensibility and elasticity, and becomes dilated or contracted in accordance with the form assumed by the contained protoplasm. It has a single opening through which the pseudopodia are protruded, and whose diameter varies with the condition of the protoplasm; but whose position is constant with regard to the nucleus, which always lies opposite to it in the fundus of the test. Besides this opening, the test is quite imperforate; and Archer was deceived in supposing that pseudopodia were emitted through orifices in its sides.

The contractile vesicles which occur along with simple, frequently very numerous, non-contractile vacuoles, lie quite in the periphery of the sarcode, and when in a state of diastole carry outward for a slight distance the part of the test which lies immediately over them.

The pseudopodia are conical and hyaline. During progression the pseudopodial opening is dilated, and the body extends itself more or less over the subjacent surface, forming with its shortened pseudopodia a kind of flattened foot on which the whole organism glides forward. It is this mode of progression, compared by the authors to that of a gasteropod, which has suggested the name of *Cochliopodium*.

The relations of *Cochliopodium* to the Monothalamia of Hertwig and Lesser cannot be overlooked, while among these the structure of its test point out *Arcella* as its nearest ally. Perhaps, as Hertwig and Lesser remark, a continued study will render possible a union of *Cochliopodium* with *Arcella*; but in the mean time it is better to regard the two genera as distinct, and to abstain from placing *Cochliopodium* among the Monothalamia, from which it is separated by its great inconstancy of body-form.

Cochliopodium pellucidum has also been examined by F. E. Schulze *, who confirms in all essential points the description given by Hertwig and Lesser.

A terrestrial *Arcella*, which bears a considerable resemblance to

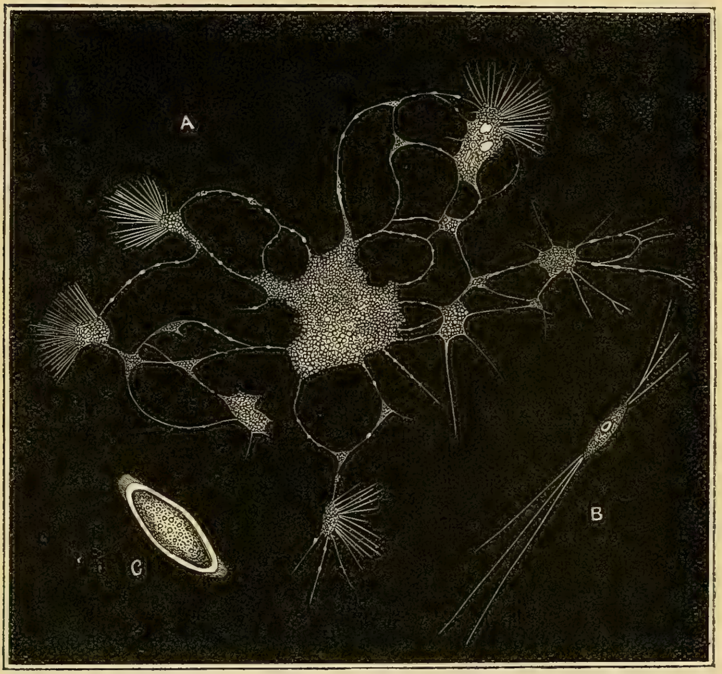
* F. E. Schulze, "Rhizopodenstudien," Arch. für mikr. Anat. vol. xi. p. 337, 1875.

the aquatic *A. vulgaris*, to be referred to in the sequel, has also been discovered by Greeff. He names it *A. arenaria*.

To Cienkowski we are indebted for the discovery and investigation of another very simple sarcodic organism to which he has given the name of *Labyrinthulea**.

He found it among the lower algæ which cover the piles in the harbour of Odessa, where it is represented by two species, which he names *L. vitellina* (fig. 7 A) and *L. macrocystis* (fig. 7 B, C).

Fig. 7.



Labyrinthulea vitellina. A. The entire organism, with the fusiform bodies wandering over the filamentary network. B. One of the fusiform bodies of *L. macrocystis* still further magnified, showing its nucleus with nucleolus. C. The same, entering into the resting stage. (After Cienkowski.)

It consists of a central mass of sarcode from which are given off thread-like prolongations which divide and subdivide and inosculate with one another, forming a net-like or dendritic ex-

* "Ueber den Bau und die Entwickl. der Labyrinthulen," Arch. f. mikr. Anat. vol. iii. 1867.

pansion, which in its ultimate ramifications consists of filaments of extreme tenuity. On this complicated plexus may be noticed in constant motion peculiar spindle-shaped bodies which, in *L. vitellina*, are of an orange-red colour, and which glide in all directions along the course of the filaments.

The central mass consists of a multitude of little sarcode spherules, the whole being held together by a soft, finely granular substance, which at the periphery forms a thin enveloping layer. Small aggregates of a similar sarcode occur also on various parts of the filamentary network, where, however, they are not held together by a cortical layer, as in the great central mass. From these smaller aggregates there also run in various directions branching and anastomosing filaments, along which the orange-red spindles glide.

Cienkowski has shown the identity of the moving spindles with the spherules of the central mass. He has seen these spherules become fusiform at the periphery of this mass and then leave it in order to wander along the course of the filaments.

After several hours it will be seen that the greater part of the spherules have assumed the spindle shape, and, abandoning the central sarcode, have entered the filaments and wandered to the margin of the plexus.

The spindles are little masses of protoplasm destitute of a membrane and very mutable in form. Each encloses a nucleus with nucleolus, and multiplies by division. They are therefore true membraneless cells. They exhibit no motion, except in the paths formed for them by the branching filaments.

Cienkowski describes the filamentary tracts along which the spindles wander as destitute of contractility, showing no motion, and never projecting pseudopodia. He regards the whole plexus as a rigid non-mobile structure, and believes that its component filaments never become fused together, but only touch one another and adhere. He has, moreover, followed its formation, and from a piece of the central protoplasm showing at first no trace of the filaments, he has seen a complicated plexus developed in the course of a few hours. He regards it as a gelatino-fibrous excretion of the spindles.

If this be a correct view of the nature of the plexus, it is obvious that the cause of the motion is to be sought for in the spindles themselves, and not in the paths over which they wander. This, however, is scarcely in accordance with the known pheno-

mena presented by protoplasmic organisms in general; and we should be more disposed to believe that the filaments are truly sarcodic and contractile, and that the spindles travel along them as foreign particles travel along the pseudopodia of other species. This is certainly the case in the closely allied *Chlamidomyxis labyrinthuloides* of Archer; and in our efforts to discover the true nature of the phenomenon in *Labyrinthulea*, the analogy of this curious organism can scarcely be ignored.

In *Labyrinthulea macrocystis* Cienkowski has observed the passing of the organism into the resting state. The first indication of this consists in the fact that the cells, whether those which are contained in the central mass or those which wander along the filaments, attain a considerable size and become richer in granules and darker in colour. The spindle-shaped cells gradually assume an oval shape, while each has its surface hardened into a membrane, and the whole becomes surrounded by a common, smooth, thick investment. In this way all the cells of the colony, cemented by a common cortical substance into a globular or vermiform mass, remain for many weeks unchanged.

After these aggregations of cysts had remained in sea-water for about six weeks, the contents of each cyst were observed to have become divided into four parts, the cyst-envelope at the same time becoming very soft and finally disappearing, so as to allow the four divisions to escape as free moving spherules. Soon after this the *Labyrinthulea*-cells with their accompanying filaments had made their appearance. He has not actually seen the change of the liberated spherules into the *Labyrinthulea*-cells, but he has no doubt of its reality.

Mr. Archer, of Dublin, has described, with excellent figures, a very remarkable organism which in many respects possesses intimate relations with Cienkowski's *Labyrinthulea*. He found it in fresh water, and named it *Chlamidomyxis labyrinthuloides** (fig. 8).

It has a soft sarcodic body surrounded by an outer tough cyst, which is of a very irregular outline, is composed of many layers, and shows distinct cellulose reaction.

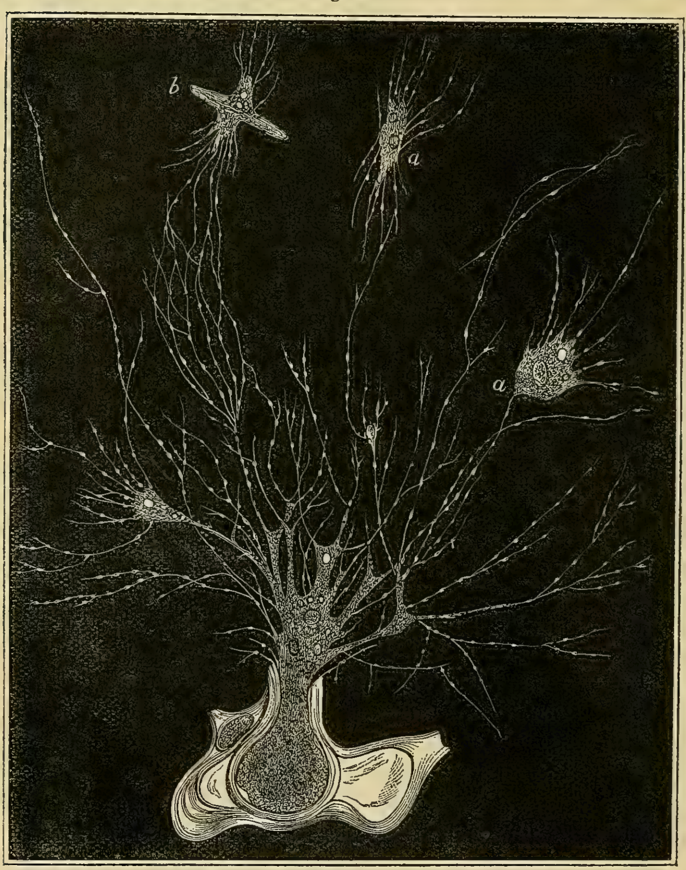
The sarcode contents are composed of a basic hyaline substance, in which are immersed various kinds of granules. Among these are certain homogeneous rounded corpuscles of a pale bluish tint, which, as we shall presently see, take an important part in the

* "On *Chlamidomyxis labyrinthuloides*," Quart. Journ. Micr. Soc. vol. xv.

vital phenomena of the organism. Notwithstanding the toughness of the cyst, the contents can burst their way through it, and the protoplasm then pours forth, carrying with it its imbedded granules, and spreading itself out over the field of the microscope. It now shows a beautiful play of very numerous globular pulsatile vacuoles.

The first part of the protoplasm which issues from the cyst

Fig. 8.



Chlamidomyxis labyrinthuloides. The protoplasm pouring itself out of the cyst, and the fusiform bodies travelling in all directions over the filamentary plexus. *a a*, isolated masses of protoplasm showing themselves in the filamentary plexus; *b*, a navicula seized for ingestion and about to be carried into the main mass of protoplasm. (After Archer.)

forms a main trunk, which soon subdivides into branches from which others are emitted; and in a short time we see a complex system of ramifications extending far and wide, and formed by hyaline, quite colourless threads of extreme tenuity.

At the same time there appear in these threads minute fusiform bodies of a pale bluish colour, which may be seen to be in constant motion along them. They are identical with the round bluish granules of the central mass; and it is only on leaving this to wander along the filaments that they assume the fusiform shape.

Archer has found no nuclei in any part of his *Chlamidomyxis*, either in the central protoplasm or in the moving spindles. Foreign bodies which had been ingested as nutriment were not unfrequent in the protoplasm of even the completely encysted organism. The whole of the protruded protoplasm can again withdraw itself into the cyst, and then, by the excretion of a wall, shut itself completely in.

The only thing which he has seen bearing any evidence of a reproductive process is a subdivision of the contents of the cyst into globular masses, which, at first naked, become afterwards invested by a special membrane.

From Archer's observations it would seem that *Chlamidomyxis* originates parasitically in the cells of *Sphagnum* and other water-plants, and that it afterwards quits the cavity of the cell and becomes external.

It is plain that in *Chlamidomyxis* we have a form very closely allied to *Labyrinthulea*. From this it differs in possessing an external, laminated, cellulose cyst, which appears to be constant, and not, as in many other low sarcoid organisms, confined to a resting-period in the cycle of development. The absence of nuclei in the fusiform bodies is another difference of importance. But the most important point in which *Chlamidomyxis* differs from *Labyrinthulea*, as described by Cienkowski, is found in the nature of the filamentary plexus which forms the paths along which the fusiform bodies perform their strange wanderings. This, instead of being formed of a rigid non-vitalized excretion, as is maintained by Cienkowski to be the case in *Labyrinthulea*, is shown by the observations of Archer to form in *Chlamidomyxis* a contractile net of living protoplasm; and the motions of the fusiform bodies along the filaments, which was so difficult to explain in *Labyrinthulea*, will be easily understood in *Chlamidomyxis*, where it is obviously

referable to the contraction of the protoplasmic network. It is here comparable to the well-known granule-currents in sarcode filaments. One can hardly help believing, however, that the real nature of the filamentary network in *Labyrinthulea* has been misunderstood by Cienkowski, and that in this, as well as in *Chlamidomyxis*, it constitutes a true protoplasm-net.

The long-known "sun animalcule," *Actinophrys sol*, has recently been studied by Hertwig and Lesser *. These excellent observers have especially attended to that part of its structure which was maintained by Grenacher to correspond to the central capsule of the Radiolaria, and have shown it to be a large nucleus with nucleolus, as, indeed, Stein had already maintained to be the true import of this body in *A. oculata*, a closely allied marine form.

The researches of Hertwig and Lesser have now left no uncertainty regarding the structure of this most interesting little Rhizopod, so that a definition more exact than any hitherto attempted can be given of it. The true conception of *A. sol* would be thus, according to these observers, that of a spherical Rhizopod with the protoplasm forming its central part homogeneous and that of its peripheral part vesicular. In its peripheral portion is a single contractile vacuole, which projects far beyond the surface. In the centre of the body is the nucleus with a distinct membrane and large nucleolus. The pseudopodia, which radiate in all directions from the surface, are provided with an axis-filament; they are loaded with granules, seldom anastomose, and never branch.

The union of numerous individuals of *A. sol* into a single mass has often been observed. The number thus fused together is variable and has been estimated at from two to nine; and the fusion is so intimate that it is impossible to demonstrate the boundaries of the component individuals, the compound mass appearing as a single *Actinophrys*. The nuclei, however, remain distinct, and give evidence of the composition. The tendency to combine shows itself also in the pseudopodia, which, in the compound masses, exhibit numerous anastomoses with one another.

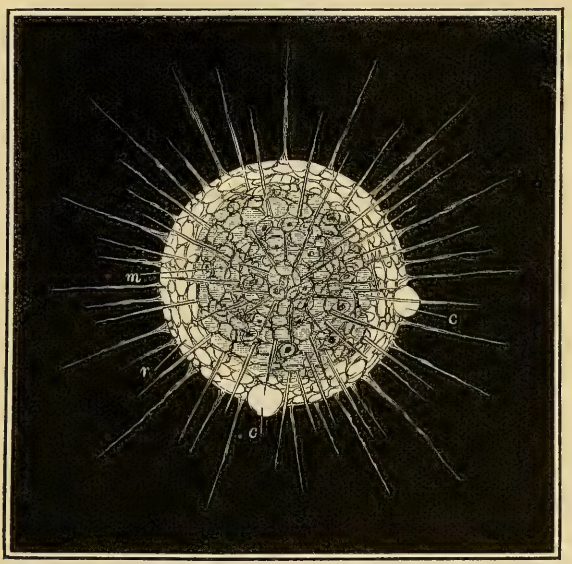
The individuals which have thus become amalgamated may separate from one another and then become once more united into a common mass.

It is not at all likely that this phenomenon of conjugation has any thing to do with a truly sexual differentiation; nor can we, indeed,

* *Loc. cit.*

discover in it any important bearing on the life-history of the animal: as a manifestation, however, of the properties of living protoplasm it is full of significance.

Fig. 9.



Actinosphærium Eichhornii. General view of the entire Rhizopod. *m*, medullary region (endosarc); *r*, cortical region (ectosarc); *c c*, contractile vacuoles. (After Hertwig and Lesser.)

Franz Eilhard Schulze* has made some interesting observations on the structure and development of *Actinosphærium Eichhornii* (figs. 9 and 10), which had been generally confounded with *Actinophrys sol*, until Stein † insisted on the value of the differences between them, and separated the two as distinct genera.

The most important steps, however, in our knowledge of this fine Rhizopod had already been made by Kölliker‡ and by Max Schultze§. Kölliker had drawn attention to the peculiar vesicular or "alveolar" structure of its sarcode, and to the differentiation of this into two regions—a more opaque central or medullary region (endosarc), and a clearer peripheral or cortical region (ectosarc); while he showed that numerous nuclei were included in

* "Rhizopodenstudien," Arch. f. mikr. Anat. vol. x. 1874.

† Abhandl. der böhmischen Akademie der Wissensch. 1857.

‡ Zeitschr. f. wissensch. Zool. vol. i. 1849.

§ Das Protoplasma der Rhizopoden u. der Pflanzenzellen, 1863.

the central mass. Max Schultze had further made the important discovery that the pseudopodia of *Actinosphærium* possess a more complex structure than had been imagined—that they consist of a firmer hyaline strongly refringent axis, surrounded by a soft, granular, mobile layer, in which alone the protoplasmic granule-streams exist. The axis was followed by him through the clear cortical zone of the Rhizopod, as far as the boundary of the darker medullary region, while the soft sarcode by which the axis is surrounded was shown to be a continuation of the cortical zone of the body.

F. E. Schulze now gives his support to the essential points of an observation made by Greeff, and maintains with that author that the axis filament of the pseudopodia is not simply a continuation of the central sarcode, but that it consists of a firm albuminous "spine," which, passing through the superficial zone, rests upon the periphery of the central sphere by a wedge-shaped extremity.

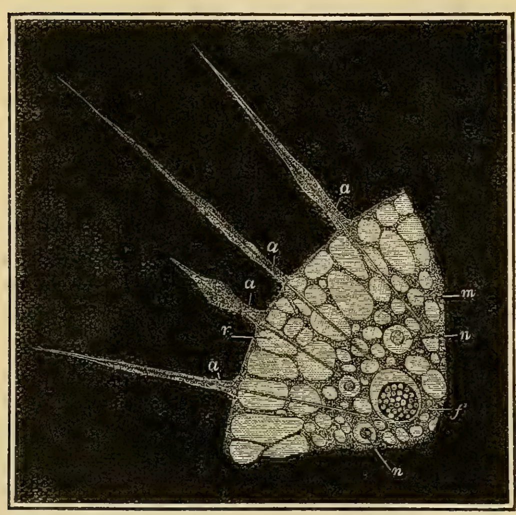
In his observations on the development of *Actinosphærium*, Schulze has been preceded and, to some extent anticipated, by Cienkowski* and by Schneider†. Schulze records the following phenomena as characterizing the reproductive process in this Rhizopod. The medullary region becomes darker, more condensed, and more sharply separated from the cortical region; the axes of the pseudopodia become indistinct and finally disappear, and the whole of the pseudopodia are withdrawn. The entire animal becomes now enveloped in a clear gelatinous excretion, and within this the body, by a process of binary segmentation, becomes broken up into a multitude of spherical masses, each with its medullary and cortical regions, but in which no distinct alveolar condition is any longer apparent. In each there is a single central nucleus, and the cortical layer, as had been already shown by Schneider, now becomes converted into a firm investment by the deposit of siliceous particles.

After remaining in this state unchanged during the whole of the winter months, the germs were observed at the beginning of spring to have lost their siliceous covering and to have become converted into minute *Actinosphæriæ*, most of which contained as yet only a single nucleus. With the growth of the young *Actinosphæria* the nuclei became multiplied and arranged themselves towards the periphery of the medullary region as in the adult animal, thus closing the cycle of development.

* Archiv f. mikr. Anat. vol. i. p. 229.

† "Zur Kenntniss der Radiolarien," Zeit. f. w. Zool. Bd. xxi. p. 507.

Fig. 10.



Actinosphærium Eichhornii. Optical section through a part of the margin. *m*, endosarc; *r*, ectosarc; *a a a*, pseudopodia, the axis filament passing through the ectosarc into the endosarc; *n n*, nucleus with nucleolus; *f*, an ingested food-mass. (After Hertwig and Lesser.)

The fusion of two or more fully developed individuals, as in *Actinophrys*, has also been frequently observed in *Actinosphærium*.

Actinophrys and *Actinosphærium* had been united by Haeckel into a small group, to which he assigns the name of *Heliozoa*. Since then, however, their structure has been found to be far more widely represented than had been imagined by Haeckel; and the Heliozoa have received large additions from certain rhizopodal forms occurring chiefly in fresh water. These have been mostly referred by their discoverers to the Radiolaria, which many of them resemble in external form. Their affinities, however, are undoubtedly with *Actinophrys* and *Actinosphærium*, and their systematic place is among the Heliozoa. The establishment of this group thus constitutes an important step in the systematic zoology of sarcodic organisms.

We are indebted to several recent observers, and more especially to Greeff, Archer, F. E. Schulze, Focke, and Hertwig and Lesser, for a long series of interesting researches on these Radiolaria-like organisms of fresh water. The discovery of freshwater forms resembling the true Radiolaria, which have been hitherto known

only as inhabitants of the sea, has for some years been rewarding the researches of several investigators of the lower forms of life.

It is to be regretted, however, that their descriptions are in many instances very contradictory, and often differ from one another so much as to render it difficult to find in them grounds for a satisfactory conclusion regarding the true structure of the organism which forms the subject of investigation *.

There can be no doubt, as has just been said, that the affinities between these freshwater organisms and the true Radiolaria have been exaggerated. Hertwig and Lesser, in their valuable memoir †, already frequently referred to, enter fully into the question of the relation between these Radiolaria-like organisms and the true Radiolaria, and arrive at the conviction that there is no close affinity between them, and that the proper allies of the freshwater forms are the long-known "sun-animalcules" *Actinophrys* and *Actinosphærium*, with which they accordingly associate them in the natural group of the Heliozoa.

In order to aid us in forming an accurate judgment on this question, it may be well to bring together here the more important characters of the true Radiolaria. From the researches of Huxley, and more especially of Johannes Müller and of Haeckel, we are now well acquainted with the structure of certain minute organisms known to the popular observer chiefly by the beautiful little siliceous shells which Ehrenberg had described under the name of *Polycystina*, and which, with their allied forms, constitute a well-defined zoological group. To this group Müller has assigned the name of *Radiolaria*. It consists of minute, sarcodic, more or less spheroidal organisms, which are usually provided with beautifully symmetrical siliceous skeletons, either in the form of perforated cases or of radiating spines, and whose body presents two concentric zones, the inner separated from the outer by a chitinous capsule ("central capsule"), and composed of numerous true nucleated cells. In almost every instance peculiar cells are also found imbedded in the sarcode which forms the outer or extracapsular zone. These cells contain a yellow pigment, and constitute the so-called "yellow cells."

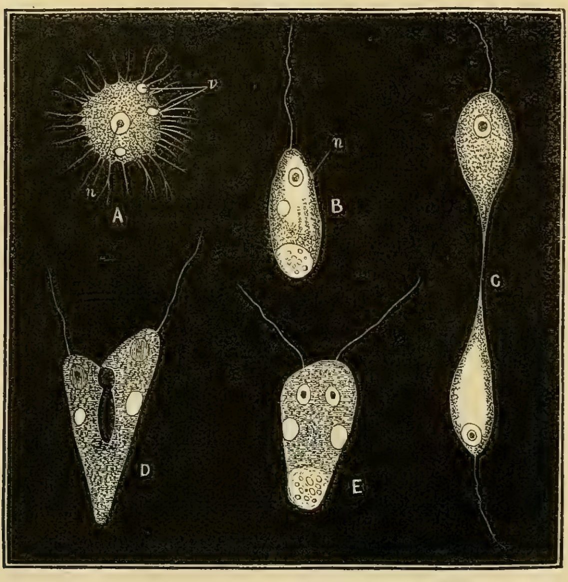
* Since the reading of the present Address an excellent *résumé* of recent researches among the Heliozoa and other rhizopodal forms, with valuable critical remarks, has been published by Mr. Archer. See 'Quart. Journ. of Micr. Sci.' for July and October 1876 and January 1877.

† "Ueber Rhizopoden u. denselben nahestehende Organismen," Archiv f. mikr. Anat., Band x. Suppl. Heft 1874.

If these characters be borne in mind, we shall have no difficulty in determining how far the freshwater organisms now about to be mentioned admit of a comparison with the true Radiolaria.

Among these freshwater Rhizopods the form which comes nearest to *Actinophrys* and *Actinosphærium*, and hence to the typical Heliozoa, is that of *Ciliophrys* (fig. 11). Under this name Cienkowski has described a new genus of heliozoal Rhizopods, represented by a single species, *C. infusionum*, which he finds common in the scum of long-standing infusions, and on which he made some important observations, showing that the swarm-spore enters into its development-cycle*. It is thus, if we except a fragmentary observation by Archer on what he regards as a large green variety

Fig. 11.



Ciliophrys infusionum. A, the *Ciliophrys* in its developed condition; *v*, contractile vacuoles; *n*, nucleus. B, the swarm-spore into which the *Ciliophrys* has become converted. C, the *Ciliophrys* in the act of self-division; each half has become converted into a swarm-spore. D, the two swarm-spores of C becoming fused into one another. E, the fusion further advanced. (After Cienkowski.)

* "Ueber einige Rhizopoden und verwandte Organismen," Arch. fur mikr. Anat. vol. xii. 1876.

of *Actinophrys sol*, the only naked heliozoan in which swarm-spore formation has been seen.

It has quite the habit of *Actinophrys sol*, except in being much smaller; and it also agrees with it in most points of structure. It has, however, one to three very small contractile vacuoles instead of the single large vacuole which in *Actinophrys* becomes, during the diastole, protruded like a bubble from the surface of the body.

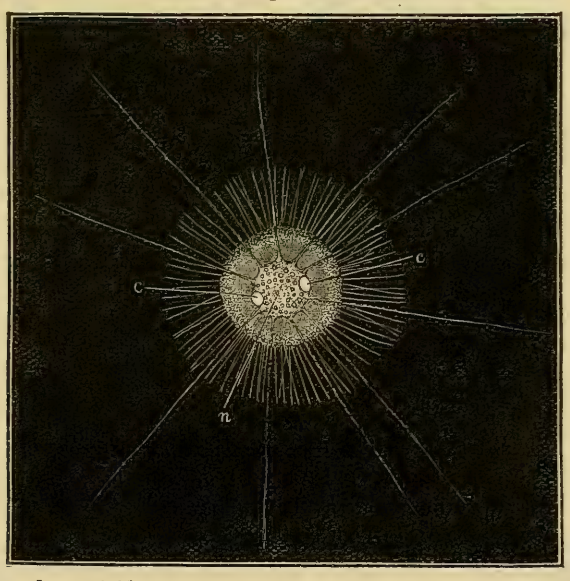
Its reproduction has been observed by Cienkowski, who finds this to be connected with a true swarm-spore formation; but instead of the locomotive germs being, as in other cases, thrown off in large numbers, it is a remarkable fact that the whole body changes into an oviform swarm-spore, with one or two cilia.

This change is preceded by the originally coarsely granular protoplasm becoming gradually homogeneous and the nucleus more conspicuous. In the meantime the pseudopodia disappear, the body assumes an oval form, and the nucleus changes its position, passing from the centre towards one end. On this end we soon perceive one or two cilia, by whose vibration the swarm-spore, now completed, is carried away through the surrounding water. Cienkowski, however, has not been able to follow the swarm-spore through any further phases.

Ciliophrys, like *Actinophrys sol*, also multiplies by constricting off portions of its body; and, like *Actinophrys*, two or more individuals may unite and fuse together into a simple mass. It is not only the fully developed *Ciliophrys* which possesses this property; for two swarm-spores may also fuse with one another. He observed a *Ciliophrys* dividing by constriction, when each half became changed into a swarm-spore. These had already retracted their pseudopodia and had developed cilia on their free ends, but still remained at the opposite ends united to one another by a narrow bridge. The connecting bridge now became suddenly bent so as to bring the sides of the two swarm-spores into contact and allow them to fuse together, forming a single two-lobed body, each lobe carrying its cilium and containing within it a nucleus. The fusion became more intimate, and the bilobed body gave place to one of a triangular form, on whose flattened base were still to be seen the cilia and, in its interior, the two cell-nuclei. Its rapid motion prevented his following its further changes; and he is unable to form any conclusions as to the real significance of the conjugation or the ultimate destiny of the swarm-spores.

Besides the truly naked Heliozoa, represented by *Actinophrys*, *Ciliophrys*, and *Actinosphærium*, a large number of others have been discovered, which, as shown by Archer, are enveloped in a soft outer investment, which he describes as an outer sarcode zone, and which may be either entirely destitute of hard parts, or which may have immersed in it hard skeletal parts, chiefly in the form of spines or spicula. The chlorophyl and other coloured granules which are frequently present in the inner body mass are never developed in this outer zone; and it is in the inner body that the pseudopodia always have their origin, merely passing through the outer zone on their way to the surrounding water. Whether this zone, however, is to be regarded as a true sarcode layer is extremely doubtful. It is, at all events, quite distinct from the proper ectosarc which it surrounds, and is probably only an excretion from this, comparable to the gelatinous excretion which is poured out on the surface of many of the lower Algæ. Hertwig and Lesser go so far as to deny its existence, and refer the appearance of an outer sarcode-like zone to an entanglement of needles and spines, even in those cases where Archer refuses to

Fig. 12.



Heterophrys spinifera. *c c*, contractile vacuoles; *n*, central dark body (endosarc or nucleus). (After Hertwig and Lesser.)

admit the presence of hard skeletal structures. The evidence, however, appears to me to be against the view thus taken by the German microscopists.

Among the forms described by Archer as developing no hard parts in the outer zone is the genus *Heterophrys*, Archer (fig. 12). In this there is a central spherical body-mass differentiated into endosarc and ectosarc, having in the endosarc a single nucleus, and in the ectosarc contractile vacuoles. The investing zone is traversed by long, granular, unbranched and non-anastomosing pseudopodia, and its periphery is extended into radiating processes of various length and fineness in the different species. These processes are regarded by Archer as simple extensions of the surface of the investing layer, which he believes to be entirely destitute of hard parts, while Hertwig and Lesser regard them as spines, and accordingly place the genus *Heterophrys* among their *Heliozoa skeletophora*.

Between such able observers it is difficult to decide; but it appears to me that the weight of evidence is in favour of Archer's interpretation, and that *Heterophrys* has no hard parts which can be regarded as constituting a skeleton like that in the true skeletophorous Heliozoa.

The enveloping zone has the appearance of being separated from the proper body by a narrow clear interval. This, as maintained by Archer, is probably only an inner layer of the zone more homogeneous and pellucid than the rest.

In *H. myriopoda*, Archer, the ectosarc of the spherical body-mass contains a dense layer of chlorophyl granules which lies just beneath its surface.

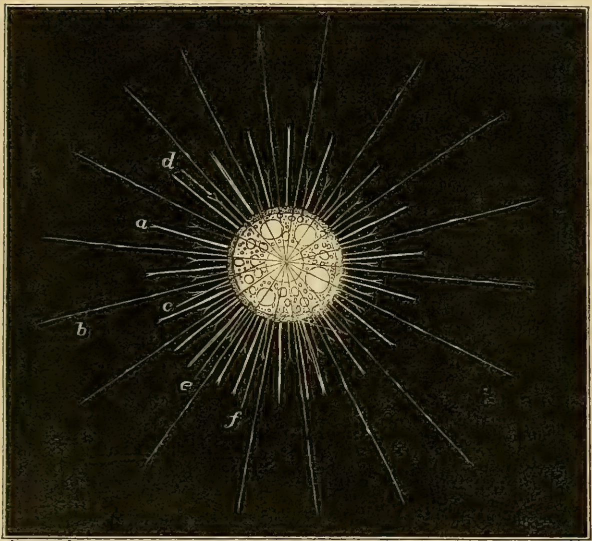
Among Heliozoa with well-developed skeleton must be mentioned the species of *Acanthocystis*. The genus *Acanthocystis* had been founded by Carter on the *Actinophrys viridis* of Ehrenberg; and what he regards as a second species of this genus has been described by him under the name of *Acanthocystis turfacea* (fig. 13). This is a beautiful little green rhizopod, which occurs in moor-pools; and Greeff now gives us the results of some further careful observations he had made on it*.

From the surface of its spherical body, which is filled with green granules, and contains a great number of vacuoles and certain

* "Ueber Radiolarien &c. des süssen Wassers," Archiv f. mikr. Anat. v. 1869. Both Greeff and Grenacher regard *A. turfacea*, Carter, as identical with the *Actinophrys viridis* of Ehrenberg; but the correctness of this determination is not admitted by Archer or by Hertwig and Lesser.

pale glistening homogeneous spherules, there radiate needle-shaped processes like the spines of an *Echinus*; and between these are emitted long slender pseudopodia. The spines are composed of silica; and each forms at its proximal end a disk-like foot. These basal disks constitute by their approximation a nearly closed siliceous capsule, by which the body is surrounded. The bases of the spines appear to be immersed in a soft sarcode-

Fig. 13.



Acanthocystis turfacea, as seen in optical section through the centre. *c*, vesicle-like space, from whose central corpuscle fine filaments are seen radiating; *b*, pseudopodium; *e*, proper body-mass, consisting of a granular protoplasm with green and pale corpuscles and enclosing numerous vacuoles; *f*, external narrow clear zone; *a*, one of the long radiating spines; *d*, one of the short spines. (After Greeff.)

like substance, which would seem also to intervene between the basal plates and the proper body of the *Acanthocystis*, which becomes thus surrounded by an external clear zone. The pseudopodia possess a firmer axis-filament and a more mobile cortical layer. Greeff states that he has seen the surface open here and there and allow the exit of strong protoplasm-streams, and again completely close, leaving no evidence of any breach of continuity. Some of these streams surround the spines, and run up and down them like the mobile cortical layer on the axis-fila-

ment of the pseudopodia. Grenacher has described a central rather large stellate space containing a clear liquid, and having in its centre a little spherical corpuscle, from which radiate a multitude of very fine lines which he believes to represent the continuation of the axis-filaments of the pseudopodia. This observation has been accepted in its essential points by Greeff, though neither Archer nor Hertwig and Lesser have as yet succeeded in satisfying themselves of its correctness.

Reproduction takes place by a direct division of the entire animal into two parts. Greeff has also observed a peculiar encysting process in which the sarcode body withdraws itself from the outer walls, contracts into an internal globe, and becomes surrounded by a hyaline organic membrane. The spines still remain on the outer walls; but the pseudopodia have disappeared, and the surface becomes covered by a delicate hyaline, but strong and impenetrable, siliceous investment. The pale glistening homogeneous spherules which accompany the green granules now undergo a rapid increase, and are probably the spores of the *Acanthocystis*; but Greeff has not succeeded in following the process further, and its true import remains undetermined.

Notwithstanding the fact that *Acanthocystis* is destitute of the essential points of Radiolarian structure enumerated above, Greeff maintains its close affinity to the Radiolaria. The outer siliceous skeleton, with pseudopodia emitted between the spines, and having their firm axis coming from the interior of the protoplasm, and apparently from a central capsule-like structure, are all points on which he insists as affording evidence of close Radiolarian relations; and he accordingly assigns to *Acanthocystis* a position in the neighbourhood of the Acanthometridæ of Haeckel.

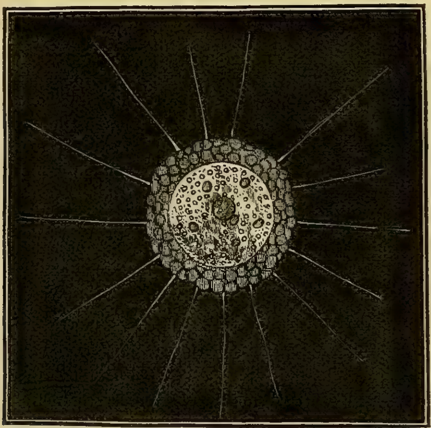
Some other species of *Acanthocystis* have also been described. Of these, *A. spinifera*, Greeff, has been well studied by Hertwig and Lesser, who have pointed out a very decided differentiation between ectosarc and endosarc. They describe contractile vesicles in the ectosarc, and in the endosarc an eccentric nucleus with nucleolus.

Among other forms which are characterized by the presence of certain hard or skeletal structures must probably be placed the genus *Astrodisculus* of Greeff.

Greeff gives the generic name of *Astrodisculus* to certain freshwater Rhizopoda, among which he has distinguished several species, which are all rendered striking by the central sarcode body being surrounded by a broad clear zone. This outer

zone is composed of a soft hyaline substance, and, according to Greeff, is bounded externally by a very delicate siliceous capsule, perforated by minute openings, through which the pseudopodia are emitted, and through which Greef believes he has seen nutritive corpuscles pass. The existence of a perforated siliceous capsule, however, has not been accepted by other observers; and Hertwig and Lesser think it probable that all the species referred by Greeff to his genus *Astrodisculus* would with more justice go into Greeff's genus *Hyalolampe*, identical with the *Pompholyxophrys* of Archer.

Fig. 14.



Hyalolampe fenestrata—the protoplasm body, with its nearly central nucleus, surrounded by its siliceous test, between whose component spherules the pseudopodia are emitted. (After Greeff.)

Greeff describes*, under the name of *Hyalolampe fenestrata* (fig. 14), a most interesting and characteristic form, in which the sarcode body is surrounded by a very elegant siliceous shell, which has the appearance of being formed of little glass spheres laid one on the other. He believes the shell to be perforated for the emission of the pseudopodia.

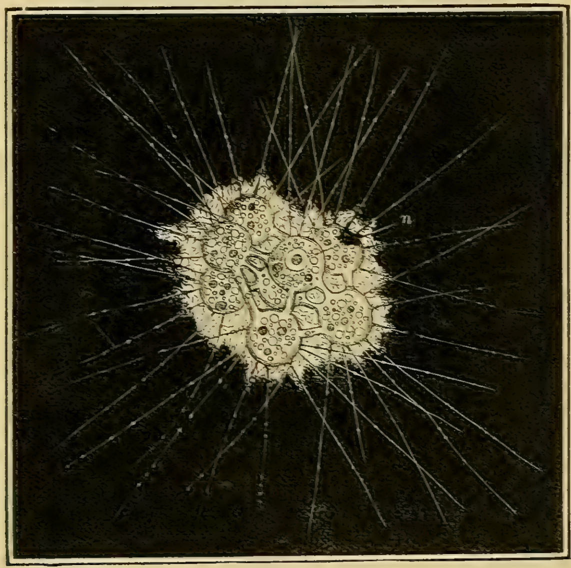
Nearly simultaneously with Greeff, but claiming the priority by some days, Archer had described, under the name of *Pompholyxophrys punicea*, the same rhizopod, which he found not unfrequently in moor-pools in various parts of Ireland. It has been more recently examined by Hertwig and Lesser†, who have supplemented and corrected the descriptions given by Greeff and Archer.

* *Loc. cit.* † *Loc. cit.*

They have verified Greeff's description of the skeleton as composed of layers of hyaline siliceous globules; but, like Archer, they tail to discover perforations in it, and find that the globules are out loosely connected with one another and are easily detached during the passage between them of nutritive matter. There is a single nucleus, and also contractile vacuoles. The pseudopodia which pass out between the siliceous globules are destitute of granules, and rarely show any tendency to branch.

Another beautiful genus of skeletophorous Heliozoa is *Raphidiophrys*, Archer. In the species referable to this genus the spherical body-mass is probably in every case differentiated into en-

Fig. 15.



Raphidiophrys elegans. A colony of eight individuals united to one another by bridges of protoplasm, the whole surrounded by a soft granular investment, in which are immersed minute curved spicula, and through which the pseudopodia are seen passing from the inner spheres to the surrounding water. *n*, nucleus, with its nucleolus visible in one of the component spheres. (After Hertwig and Lesser.)

dosarc and ectosarc, and contains in the endosarc a single nucleus, while from the periphery radiate in all directions very long unbranched granular pseudopodia.

External to the proper protoplasm-sphere is a soft granular

investment, in which is immersed an immense number of tangentially or irregularly disposed, curved siliceous spicula, and through which the pseudopodia pass from the surface of the inner sphere to the surrounding water. The species of *Raphidiophrys*, however, are usually found in the condition of colonies. One of these colony-forming species, *R. elegans* (fig. 15), has been described and figured by Hertwig and Lesser as a cluster of globes united rather loosely to one another by thin bridges of protoplasm, across which the sarcode currents may be seen passing from one globe to the other, while the whole cluster is surrounded by the common soft investment in which the spicula are immersed, and which allows the passage across it of the long fine pseudopodia from the periphery of the included globes.

R. viridis, one of the finest of all the freshwater Rhizopoda, is described by Archer*, who has taken it as the type of the genus. It is also a colony-forming species, and is distinguished by its bright green colour, caused by a dense stratum of chlorophyll granules which lie just within the periphery of each of its component spheres.

Under the name of *Pinacocystis rubicunda* (fig. 16), Hertwig and Lesser have described an interesting skeleton-bearing heliozoan which they found in sea-water. Its spherical body is surrounded by a case which consists of isolated round tablets lying close to one another, and thus forming a completely closed capsule. They compare this capsular skeleton to that of an *Acanthocystis*, in which the whole of the spines, with the exception of their basal plates, had disappeared.

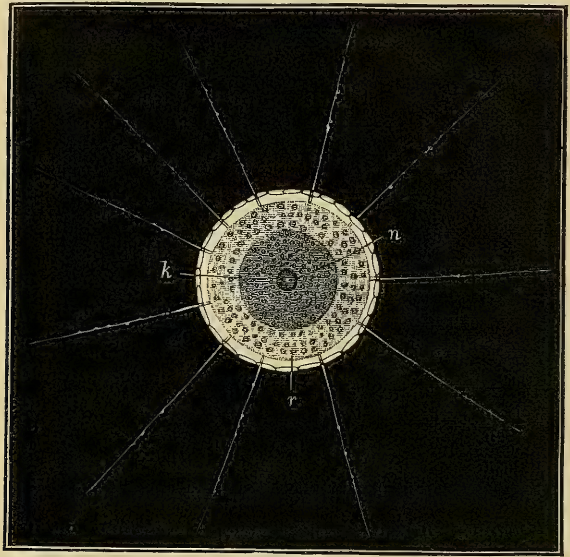
The protoplasm body is separated from the capsule-walls by an interval which would seem to correspond to the similar interval between the body and the basal plates of the spines in *Acanthocystis*. The protoplasm shows a very decided differentiation of ectosarc and endosarc. The ectosarc is loaded with brownish-red granules; and the endosarc contains a single nucleus. Contractile vacuoles could not be demonstrated. The pseudopodia are emitted through the intervals of the capsule-tablets.

A closely allied form is that of *Pinaciophora fluviatilis*, Greeff. This heliozoan was found by Greeff in freshwater streams. It resembles *Pinacocystis*, Hert. & Les., in being surrounded by a globular capsule composed of separate though closely approximated plates, but differs from it in the oval form of these plates.

* Quart. Journ. Micr. Sci. vol. xi. 1871.

and in the fact, according to Greeff, that they are traversed by minute canals for the transmission of the pseudopodia. There is a large central nucleus with nucleolus.

Fig. 16.



Pinacocystis rubicunda. *k*, endosarc; *r*, ectosarc; *n*, nucleus. (After Hertwig and Lesser.)

Acanthocystis and the other skeletophorous Heliozoa whose hard parts are in the condition of detached pieces such as spines, spicula, tablets, and the like, have been united by Hertwig and Lesser into a group to which they give the name of CHALAROTHORACA, while those whose skeleton is in the form of a connected shell have been combined into a separate group under the name DESMOTHORACA.

Among the Desmothoraca the most interesting is *Clathrulina elegans* (fig. 17), originally described by Cienkowski, who discovered it near St. Petersburg*. Greeff now gives a very full description of this beautiful little Rhizopod, which he obtained in the neighbourhood of Bonn. It had also been found by Haeckel near Jena, while a closely allied, if not identical form had nearly simultaneously with Cienkowski's discovery been observed by Archer in Ireland and in Wales.

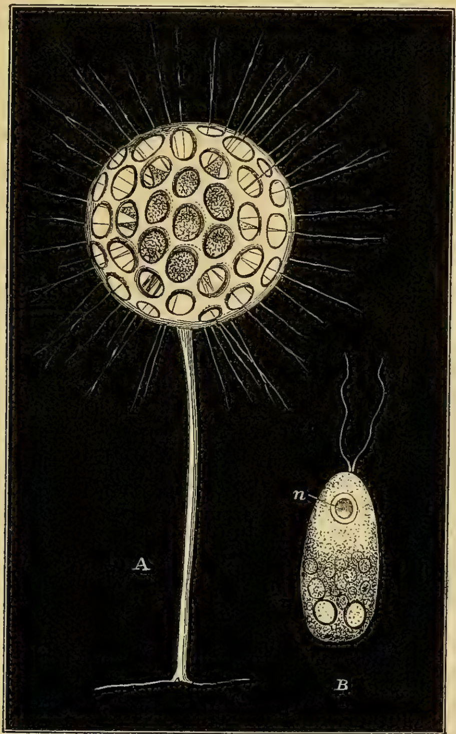
* Cienkowski, "Die Clathrulina," Archiv f. micr. Anat. 1867.

It occurs chiefly in dark ponds shaded by trees and containing decaying leaves. Its soft sarcode body is included in a siliceous capsule of a spherical form regularly perforated in the manner of latticework, and supported on a long siliceous peduncle.

Pseudopodia are projected through the latticework of the capsule; and these, as in the Actinophryidæ, are composed of an axis-substance, and a cortical substance. The axis has been followed into the interior of the protoplasm. Vacuoles which hold no stable position are scattered through the protoplasm; and there is a vesicle-like nucleus, which is rendered evident by the application of acetic acid.

Cienkowski had already shown the occurrence in *Clathrulina*

Fig. 17.



Clathrulina elegans. A. The completely developed rhizopod (after Greeff). B. A swarm-spore of *Clathrulina elegans* (after Hertwig and Lesser): *n*, nucleus; *c*, contractile vacuoles.

of two kinds of reproduction, by division and by cyst-formation. The former takes place within the capsule, and consists in the division of the contents by a transverse constriction. One of the two portions thus formed soon forces its way out through the perforated capsule, and then lives for some hours in the surrounding water as a free naked sarcodic body resembling an *Actinophrys*. It ultimately secretes a capsule and stem, and becomes a perfect *Clathrulina*.

In the second kind of reproduction there are formed within the capsule, by a process apparently of budding, numerous rounded sarcode-masses, each of which becomes enveloped by a firm covering; and they thus remain for months as spherical cysts within the common capsule. Greeff has further examined these bodies, and has shown that they contain within them a large pale nucleus, and that the walls of the cyst are set round with short spines, and are probably siliceous.

When the time has arrived for their further development, the sarcode contents slip out of their cysts and escape into the surrounding water through the latticework of the capsule. Here they swarm about for some hours in the form of ciliated oviform embryos, then become transformed into free *Actinophrys*-like organisms, which finally acquire the stem and siliceous lattice-like capsule of the perfect animal.

The resemblance of the siliceous perforated capsule of *Clathrulina* to the latticed shells of the Polycystina is sufficiently obvious; and we must admit, with Greeff, that, if we met with these little capsules free in the open sea, we should not hesitate to refer them to the true Polycystina, and place them in Haeckel's Radiolarian family of the Ethmosphæridæ. In the more essential points of structure, however, *Clathrulina* has no close affinity with the Radiolaria, from which it is widely separated by the absence of a central capsule with its multicellular contents. The absence of yellow cells is another, though less important, point which opposes itself to the association of *Clathrulina* with the true Radiolaria. Notwithstanding these differences, however, Greeff does not hesitate to refer it to the Radiolaria, and place it there, in the family of the Ethmosphæridæ.

Another Desmothoracous genus has been described by Hertwig and Lesser under the name of *Hedriocystis*. Like *Clathrulina*, the body is enclosed in a single-chambered stalked test perforated for the passage of pseudopodia; but instead of being hard and

Fig. 18.

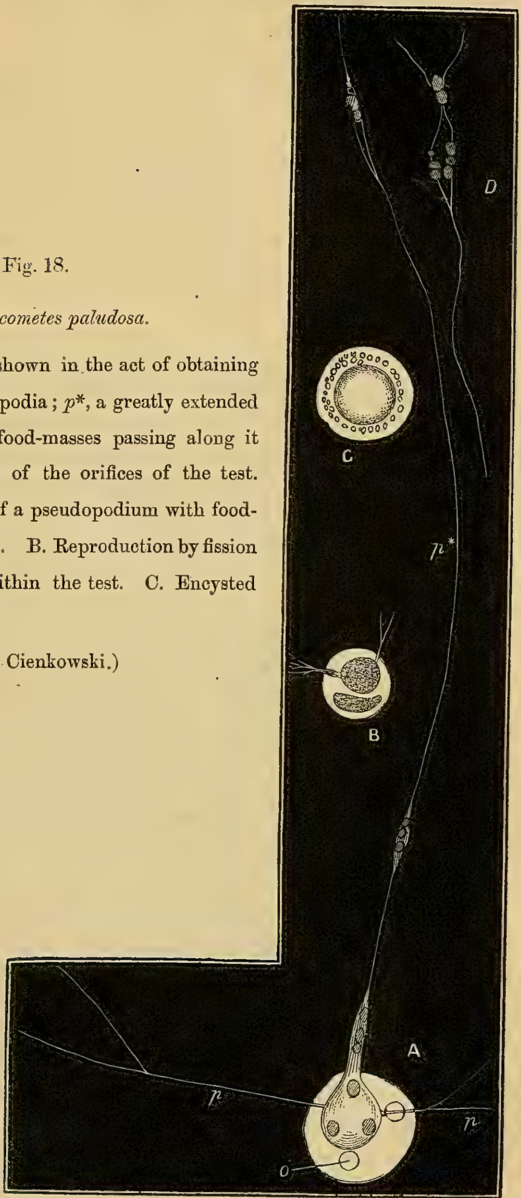


Fig. 18.

Microcometes paludosa.

A. An individual, shown in the act of obtaining its food; *p*, *p*, pseudopodia; *p**, a greatly extended pseudopodium with food-masses passing along it to the body; *o*, one of the orifices of the test. D. Distal extremity of a pseudopodium with food-particles engaged in it. B. Reproduction by fission of the protoplasm within the test. C. Encysted condition.

(After Cienkowski.)

rigid as in *Clathrulina*, it is soft, thin, and flexible, and at the perforation is continued as a very short tubular prolongation round the pseudopodia. The round protoplasm-body does not fill the cavity of the shell, but swings in it free as if hung on the pseudopodia which perforate the shell-walls. It contains an oval nucleus with nucleolus; and close to its margin are situated one or more actively pulsating vacuoles.

Reproduction by division of the body into two segments was observed with great distinctness.

Only a single species, *H. pellucida*, has as yet been discovered. It is found attached by its stalk to the filaments of Algæ and other foreign bodies.

To the Heliozoa rather than to any other group must probably be referred another interesting form which has been assigned by Cienkowski to a new genus*. He gives it the name of *Microcometes paludosa* (fig. 18). He found it in Russia among gelatinous algæ. The protoplasm-body lies free in the interior of a loose membranous capsule, whose wall, perforated in a few places, affords passage to the very long pseudopodia. The histological differentiation of its body is that of most Heliozoa, having a nucleus with a nucleolus, while two or three contractile vesicles exist in the peripheral layer. The pseudopodia, which are thrust out through the perforations in the shell, are but little branched, and are sometimes extended to a great length, in order to reach the food at a distance. The end of the pseudopodium may then be seen to flow round the nutritive particle such as an alga-spore, which, when thus captured, will move along the path of the protoplasm filament until it reaches the interior through one of the openings in the shell. During this transport the pseudopodial filament lies immovable, while new nutriment-particles move along it into the capsule.

Besides the reception of food being thus effected by the pseudopodium enveloping the nutritious particle, the *Microcometes* has also the power of perforating alga-cells with the extremity of a pseudopodium, and then sucking out their contents in the manner of a *Vampyrella*.

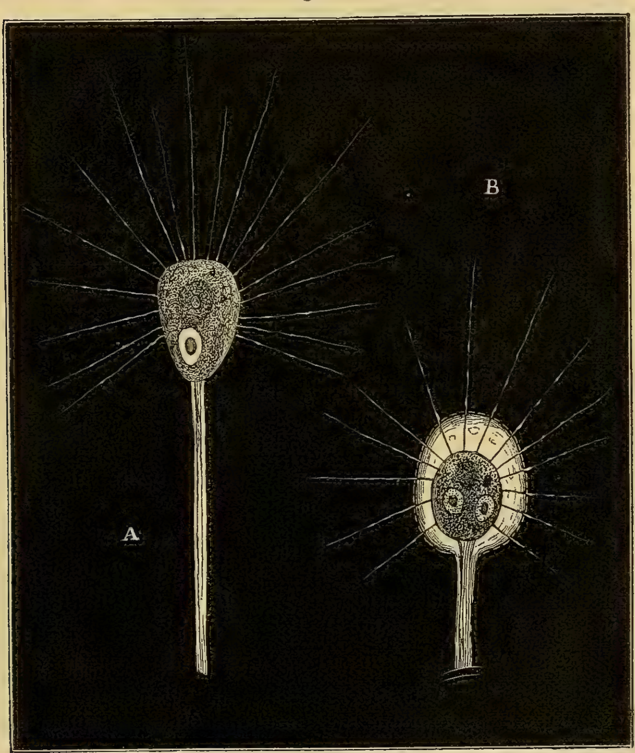
Multiplication takes place by the division of the protoplasm-body into two parts, which are pressed out through the narrow apertures in the capsule. In the development-cycle there has also been observed a resting-state, in which, without leaving its capsule,

* Arch. f. micr. Anat. vol. xiii.

the body assumes a spherical shape, and, after expelling the undigested remains of the nutriment, envelops itself in a thick membrane.

As an aberrant form of the Heliozoa, from the typical members of which it departs chiefly in the want of the permanent spherical (homaxial) form, may here be included the *Actinolophus pedunculatus* (fig. 19) of Fr. Eilhard Schulze. Under this name Schulze described a remarkable pedunculated Rhizopod which attaches itself to marine Algæ and to *Gonothyræa Loveni* and other Hydroids. It presents itself in two different states. In one the body is quite destitute of hard parts; in the other it is invested by a siliceous covering.

Fig. 19.



Actinolophus pedunculatus. A. State in which the body is destitute of hard parts. B. State in which the body is invested by a siliceous scaly covering through which the pseudopodia pass outwards to the surrounding water.
(After Schulze.)

In the first state the body has usually the form of a pear, attached by its narrow end to a long cylindrical stem. It is very contractile, however, and may assume a spherical or an egg-shaped form. No external membrane or definite cortical layer can be detected. In its interior there is always a very excentric nucleus enclosing a very large nucleolus. In the centre of the wide part of the animal lies a dark spherical body, whose true nature has not been ascertained. Its position generally corresponds to the point in which the pseudopodia if prolonged inwardly would meet; and Schulze thinks that in some cases he could trace fine lines from it to the pseudopodia. In some specimens there occurred, besides the ordinary granules, numerous orange-red corpuscles, which, along with large nutriment-pellets, lay near the periphery. No pulsatory vacuole was found*.

The pseudopodia occur only on the more distal part of the body, from which they radiate in all directions. The appearances are in favour of the pseudopodia being composed of a central firm axis and an investing cortical layer; but on this point the author cannot speak decidedly. A complete withdrawal of the pseudopodia was never seen, the contraction of these processes being at a definite distance from the surface of the body suddenly stopped, as if by the presence of a thick perfectly hyaline investment, which the author thinks is really present in the form of a gelatinous excretion from the body, but which, from its extreme transparency, is all but invisible. In this state the pseudopodia present the appearance of fine lines tipped each with a little granular mass of sarcode, and the *Actinolophus* closely resembles a *Podophrya*.

The stem is cylindrical, hyaline, and appears to be encased in a delicate sheath. In its interior may be seen several parallel, straight, longitudinal lines.

Besides the individuals so formed, others occur with a manifest outer envelope. This shows itself at first as a gelatinous investment, so transparent as to be recognized only by its boundary contour. It is traversed by the pseudopodia and by the fine parallel lines from the interior of the stem. In a stage further advanced, a layer of very delicate strongly refringent plates has formed on the surface of the gelatinous mantle, and is continued downwards over the stem. The plates appear to be composed of silica, and ultimately acquire a tolerably regular hexagonal form, but never come so close as to touch one another by their edges.

* F. E. Schulze, "Rhizopodenstudien," Arch. f. micr. Anat. vol. x. 1874.

Simultaneously with the formation of the siliceous investment certain changes are going on in the interior. The nucleus divides into two; and each half, surrounded by a peculiar clear area, recedes more and more from the other. The pseudopodia remain at first quite unchanged and fully extended; but by the time that the siliceous case is completed they have become entirely withdrawn, while the dark central body has at the same time disappeared.

The condition thus attained is probably a true encysted or resting-state, to be succeeded by a division of the contents; but Schulze was unable to follow it to its ultimate destination.

The various organisms which I have now passed before you in review are confined to certain more purely Amœboid forms and to the recently established group of the Heliozoa. We are indebted, however, to recent investigations for our knowledge of many other sarcodic beings, which, whether regarded in their completed forms or in their developmental history, are of great interest. Their introduction here, however, would extend the present address to a length far beyond its legitimate limits; and their consideration must therefore be deferred to a future occasion.

Contributions to the Ornithology of New Guinea. By R. Bowdler Sharpe, F.L.S., F.Z.S., &c. Part II.—On the Ornithological collections formed by the late Dr. James in South-eastern New Guinea and Yule Island.

[Read March 15, 1877.]

The localities where the collection now about to be described was formed, are well known to naturalists as the hunting-grounds of the Italian traveller D'Albertis, who has made us acquainted with the features of the ornithology of Yule Island and the opposite coast of New Guinea. A melancholy interest attaches to the present collection of Dr. James; for it is at once the first, and last, that we shall receive from him. This young naturalist, whose career as a traveller commenced so favourably, and whose energy trampled on so many difficulties, was murdered by natives, as mentioned in a communication of the Rev. S. Macfarlane in 'Nature' for Nov. 16, 1876:—"We have just heard of the massacre of Dr. James and his partner, a Swede, at Yule Island

by the natives of New Guinea. They had gone in their large boat to the east side of Hall Sound to shoot Birds of Paradise, when they were attacked by three canoes, and both white men were killed. The native crew managed to get away in the boat, and brought the sad news here (Somerset)." His collection of birds was placed in my hands by his friend, Dr. Alfred Roberts, of Sydney, to whom they had been consigned by the deceased traveller; and the present paper is an account of this collection. All the skins were very well prepared, and the particulars of locality, date, and sex marked in most instances. The following is an account of the places where the collection was formed, furnished by Dr. James to Dr. Roberts:—

"Aleya is the native name for a 'salt arm' which is situated on the opposite side of the mainland south-east of Yule Island, and distant about six or seven miles. This salt arm passes through an extensive mangrove swamp, and, after winding about for more than a mile in extreme length, terminates at the base of a slight rising ground, the latter being covered with dense "scrub." To the west, not over two miles distant, loom up several hills forming a short mountain-range, which runs about S.E. and N.W. Two of these hills, I fancy, are not less than six or eight hundred feet high. So this locality embodies both low swampy country and dry scrubby land."

"Nicura. This is a village of fifteen houses, and about seventy-five inhabitants, situated a little north of east from Yule Island, and about ten or twelve miles distant. It is not more than three miles distant from the coast-line. The village is situated on a *Eucalyptus*-range of hills, I fancy not over 150 feet above the level; about half a mile to the north of Nicura this range of hills is broken by the valley down which the Nicura river wends its tortuous way. To the south and south-east, however, this gravelly *Eucalyptus*-range extends for many miles. It is not very wide, is bounded on the west by Hall's Sound for part of its distance, and by a thick marginal belt of mangrove swamp—on the east by the valley of the Nicura, which is a low swampy country, in the main, supporting a very heavy growth of scrub and forest trees. It is in the latter locality that birds abound, with a few of the Paradiseidæ; along the range of hills kangaroos and birds of prey are to be found in great numbers.

"Selena is another salt arm, extending into the above-mentioned belt of mangroves and terminating at its inland margin. It is

north of east from here, and about seven or eight miles distant. It is a great native kangaroo hunting-ground.

"Paiton is a large village situated almost due north of Yule Island, and not less than fifteen miles distant. It is approached by a very small tortuous creek, which derives its water from the Anama river, I think. I fancy that Paiton cannot be less than six miles inland. It is located on a slightly elevated table-land and entirely surrounded by a low swampy country, through which runs the largest river in this section of country, and in which occur many lagoons and creeks. There are a few slightly elevated points, which are open and covered with tall grass instead of scrub. It is a fine locality for Kingfishers, waterfowl, and numerous small birds. I only made a short trip to this village in January; when I visit it again I shall take more extensive notes.

"Yule Island is about four or five miles long and two and a half or three miles wide at the widest point. On the north side, or N.E. side, a small chain of hills extends along the water-line nearly the entire length of the island. On the N.E. side of the chain dense scrub occurs, whilst on the S.W. side is only found a few clumps of scrub and abundance of grass. Then a small valley occurs dividing this chain from another of nearly equal proportions and possessing the same character. From the foot of the latter to the water-line, for a distance of nearly a mile, the island is low, slightly rolling, broken by ravines, and where not covered by banana plantations, presents a thick growth of tall grass finally terminating in a narrow marginal belt of scrub. A dense scrub occurs in the N.W. extremity, which is almost altogether low. From this latter locality nearly all my beetles have been collected. The Lepidoptera were obtained from low Yule Island in thick scrub. Not having parchment for labelling specimens in spirits, I have simply placed a general label on the outside."

The following appear to be the most important papers which have as yet been published on the ornithology of south-eastern New Guinea, with the exception of a few monographic essays by Count Salvadori on *Goura*, &c., and certain Accipitres, which will be found in the 'Annali' of the Civic Museum of Genoa:—

1. T. Salvadori e L. M. D'Albertis. Catalogo di una collezione di Uccelli dell' Isola Yule e della vicina costa meridionale della penisola orientale della Nuova Guinea, raccolti da L. M. D'Albertis. Ann. Mus. Civ. Genov. vii. pp. 797–839.

2. Sharpe, R. Bowdler. Contributions to the Ornithology of

New Guinea. Part I.—Notes on a Small Collection of Birds from South-eastern New Guinea. Journ. Linn. Soc. Zool. xiii. pp. 79–83.

3. Salvadori, T. Catalogo di una seconda collezione di Uccelli raccolti dal Sig. L. M. D'Albertis nell' Isola Yule e sulla vicina costa della Nuova Guinea e di una piccola collezione della regione bagnata dal Fiume Fly. Ann. Mus. Civ. Genov. ix. pp. 7–49.

These papers are referred to in the accompanying observations. The particulars attached to the specimens are from Dr. James's MSS. labels.

Order ACCIPITRES.

Fam. FALCONIDÆ.

1. HALIAETUS LEUCOGASTER.—H. leucogaster (*Gm.*), *Sharpe, Cat. B.* i. p. 307.—Cuncuma leucogaster, *Salvad. & D'Albert, t. c.* p. 804; *Salvad. t. c.* p. 10.

a ♀. Yule Island, Jan. 1876.

The specimen sent is quite adult, in full grey and white plumage. It measures as follows—total length 33 inches, culmen 30, wing 23·2, tail 11, tarsus 4. The dimensions of this bird, which is marked a male, are larger than those given by me in my 'Catalogue' for the female; and it is probable that some mistake has occurred in the last-mentioned work.

2. HALIASTUR GIRRENERA.—H. girrenera (*V.*); *Sharpe, Cat. B.* i. p. 315; *Salvad. & D'Albert. t. c.* p. 804; *Salvad. t. c.* p. 10.

a. Adult. Mainland of New Guinea, east of Yule Island, Feb. 1876. Beach scrub.

3. MACHÆRHAMPHUS ALCINUS, *Westerm.*; *Sharpe, Cat. B.* p. 342.

a. Low Nicura, April 1st, 1876, in very dense forest. Eyes very convex, projecting; iris bright yellow, very narrow; feet lead-colour; bill black.

This is, in my opinion, the most interesting bird discovered by Dr. James; for although not new to science, it is a remarkable fact to find a *Machærhamphus* in New Guinea, especially when one cannot find the slightest specific distinction between it and an example from Malacca. The British Museum possesses a Malaccan specimen, presented to that institution by Captain Stackhouse Pinwill; and on comparing the Nicura skin with this, I cannot perceive the slightest difference, unless it be in the slightly less amount of white on the fore neck of the latter. In size the New-Guinea bird is smaller and may be a male.

	Total length. in.	Culmen. in.	Wing. in.	Tail. in.	Tarsus. in.
a. Nicura (*James*) ...	19·5	1·3	14·5	7·5	2·15
b. Malacca (*Pinwill*)	19·5	1·4	15·6	7·4	2·6

The above measurements of the tarsus are probably more correct than that given of the tarsus in my 'Catalogue,' the difficulty of measuring the type correctly being very great, owing to the specimen having been mounted.

4. BAZA REINWARDTI.—B. reinwardti (*Müll. & Schl.*); *Sharpe, Cat. B.* i. p. 358.

a, ♀. Mainland of South-east Papua, eight miles from Yule Island, Nov. 1875.

A bird in very fine plumage. Total length 16·8 inches, culmen 1·25, wing 12·5, tail 7·8, tarsus 1·35.

5. PANDION LEUCOCEPHALUS, *Gould*; *Sharpe, Cat. B.* i. p. 451.

a, ♂. Yule Island, Dec. 1875. Total length 19 inches, culmen 1·8, wing 17·1, tail 8, tarsus 2·15.

b, ♂. Yule Island, Dec. 1875. Total length 24 inches, culmen 1·1, wing 17·8, tail 5·7, tarsus 2·35.

Order PICARIÆ.

Fam. PSITTACIDÆ.

6. TRICHOGLOSSUS MASSENA, *Bp.*; *Sharpe*, anteà, p. 80; *Salvad. t. c.* p. 16.

a, *b*, ♂ ♀. Mainland of S.E. Papua, Jan. 1876.

c. Eucalyptus range, mainland of S.E. Papua, east of Yule Island, Feb. 1876.

I can perceive no differences in the plumage of the pair above mentioned. They measure as follows:—

a, ♂. Total length 10 in., culmen 1·1, wing 4·45, tail 4·35, tarsus 0·6.

b, ♀. Total length 9·8 in., culmen 1, wing 5·2, tail 4·1, tarsus 0·6.

7. GEOFFROYIUS ARUENSIS.—G. aruensis (*G. R. Gray*); *Salvad. & D'Albert. t. c.* p. 810; *Salvad. t. c.* p. 12.—G. pucherani, *Sharpe*, anteà, p. 80.

a, ♂. Mainland of New Guinea, Jan. 1876.

I have no doubt that the female bird referred by me to *G. pucherani* (anteà, p. 80) should really belong to this species. I have compared the male sent by Dr. James with the typical examples from the Aru Islands, and I find them to be of the same species, though

the Papuan bird is rather larger and has got a more orange tint in the face, this being not so deep rosy red.

8. Cyclopsittacus cervicalis. — C. cervicalis, *Salvad. & D'Albert. t. c.* p. 811; *Salvad. t. c.* p. 12.

a. Eucalyptus range, mainland, east of Yule Island, Feb. 1876.

The following is a description of this Parrot, which has been, apparently with good reason, separated by Count Salvadori:—

General colour above grass-green, rather deeper on the mantle; head vermilion, rather more orange on the crown, the nape and hinder neck cobalt, continued in a band down the sides of the neck, which are also slightly washed with blue; sides of face and ear-coverts bright vermilion, as also the throat and fore neck, the latter mixed with orange-yellow, the bases to the feathers being of the same colour; across the chest a band of bright ultramarine continuous with the band down the side of the neck; some of the feathers of the breast below this blue band orange, with bluish green bases; remainder of under surface yellowish green, darker green on the lower flanks; the sides of the breast and under wing-coverts bright verditer-blue, the greater series yellowish; the under surface of the quills blackish, yellow along the inner webs; upper wing-coverts grass-green like the back, those near the edge of the wing blue; primary-coverts and quills blackish, externally greenish blue, with a narrow edging of yellow towards the tip of the outer web; the secondaries darker green and more like the back; tail grass-green, narrowly edged with brighter green. Total length 7·8 inches, culmen 1, wing 4·6, tail 2·1, tarsus 0·5.

Fam. Cuculidæ.

9. Lamprococcyx lucidus.—L. lucidus (*Gm.*); *Salvad. & D'Albert. t. c.* p. 813.

a. Aleya, April 1876.

10. Eudynamis cyanocephala.—E. cyano cehala (*Lath.*); *Salvad. t. c.* ix. p. 17.

a, ♂ ad. Yule Island. *b, c*, ♂ juv. Yule Island, Dec. 1876.

11. Centropus spilopterus, *Gray*; *Sharpe*, anteà, p. 81.— Polophilus nigricans, *Salvad. t. c.* p. 17.

a–c, ♂. Yule Island, Nov. & Dec. 1876. *d.* Nicura, Dec. 1876.

These specimens belong to the same species as the Port-Moresby bird referred to above (*anteà*, p. 81), and I have no doubt that *Polophilus nigricans* of Salvadori (*l. c.*) is the same species.

12. Centropus menebeki.—Nesocentor menebeki (*Less.*); *Salvad. t. c.* p. 17.

a. Aleya, April 1876. Iris bright brick-red; bill black at the base, horn-coloured at the tip; feet black.

Fam. Alcedinidæ.

13 Alcyone pusilla.—A. pusilla, *Gould*; *Sharpe, Monogr. Alced.* pl. xvi.

a, ♂. Aleya, S.E. New Guinea, April 1875. Eyes dark hazel; bill black; feet and tarsi lead-colour.

An adult bird in full moult. Total length 4·5 inches, culmen 1, wing 2, tail 0·95, tarsus 0·3.

14. Alcyone lessoni.—A. lessoni, *Cass.*; *Salvad. t. c.* p. 19.

a, ♂. Mainland of New Guinea, eight miles from Yule Island, November 1875.

This specimen agrees very well indeed with other Papuan skins of *A. lessoni*, resembling them in the large size of the bill and also in the purple shade on the flanks. In the specimen obtained by Mr. Stone the blue was confined to the sides of the breast.

15. Halcyon sanctus.—Sauropatis sancta (*V. & H.*); *Salvad. & D'Albert. t. c.* p. 814; *Salvad. t. c.* p. 19.

a, ♀. Yule Island, April 1876.

16. Tanysiptera microrhyncha, sp. n.—Tanysiptera galatea, *Gray* (var. minor), *Salvad. & D'Albert. t. c.* p. 815; *Salvad. t. c.* p. 21.

♀ ad. Similis *T. galateæ*, sed multo minor, dorso nigro, minus cæruleo lavato, rostro parvo præcipue distinguendus. Long. tot. 15·3, culm. 1·3, alæ 4·05, caudæ 10·2, tarsi 0·6.

Adult female. Crown of head and nape cobalt-blue, a little brighter round the edge of the crown and on the nape, and slightly dashed with silvery cobalt over the eye, the forehead rather duller blue; lores, feathers below the eye, and the ear-coverts black, slightly washed with deep blue, as also are the sides of neck, mantle, back, and scapulars, on which, however, the blue shade is not so apparent; wings black, the wing-coverts and secondaries externally deep purplish blue, the innermost of the greater and median coverts bright cobalt, forming a shoulder-patch; lower back, rump, and upper tail-coverts pure white, the latter with an indistinct narrow fringe of dark blue; tail white, the outer feathers more

or less edged with blue towards the tip, the two long centre feathers blue with a long white spatula, the base of these two plumes irregularly white in the centre and along the inner edge, the next two feathers with remains of blue near the base of the shaft; moustache and entire under surface of body pure white, the sides of the upper breast black; under wing-coverts white, the lesser plumes on the upper band of the wing blue-black, shading into brighter blue on the edge of the wing itself; bill red; feet dusky. Total length 15·5 inches, culmen 1·3, wing 4, tail 3·9, centre feathers 9·7, tarsus 0·6.

a, ♀ ad. Mainland of S.E. New Guinea, about eight miles from Yule Island, Nov. 1875.

b, ♀ juv. in change. *c*, pull. Iris dark brown; upper mandible black, the lower one dirty white; feet pale lead-colour. *d*. Mainland of South-east Papua, Feb. 1876.

Count Salvadori has already alluded to the smaller size of the *Tanysiptera* of south-eastern New Guinea; and this character seems so well marked in the numerous specimens which I have examined that I think the bird may well be specifically separated. For comparison with the dimensions above recorded, I now give those of some skins of *Tanysiptera galatea* in the Museum collected by Mr. Wallace.

	Total length. in.	Culm. in.	Wing. in.	Tail. in.	Centre tail-feathers. in.	Tarsus. in.
a, ♀ ad. Waigiou (*Wallace*)	13·7	1·55	4·0	4·6	8·3	0·7
b, ♂ ad. Waigiou (*Wallace*)	17·5	1·55	4·35	5·2	11·5	0·7

17. Dacelo intermedius.—D. intermedius, *Salvad. Ann. Mus. Civ. Genov.* ix. p. 15.

a, ♂. Mainland, South-eastern Papua, Jan. 1876. Total length 16 inches, culmen 2·8, wing 7·75, tail 5·3, tarsus 0·9.

b, ♀. Mainland, S.E. Papua, Jan. 1876. Total length 18 inches, culmen 2·9, wing 8·1, tail 5·85, tarsus 0·95.

c, ♀. Port Moresby, November 1876. Total length 17·5 inches, culmen 3·25, wing 8·2, tail 5·9, tarsus 1.

Adult male. Back and scapulars brown; the least wing-coverts brown, slightly washed with blue; median wing-coverts cobalt, the greater series blackish brown, washed with blue at their ends; primary-coverts blackish on the inner webs, blue on the outer quills, blackish externally; the secondaries ultramarine blue, edged

with white at the tips; the primaries white for half the inner web and at the base of the outer one; back, rump, and upper tail-coverts cobalt, the feathers of the upper back white washed with lilac, the tips only being blue; tail blue, tipped with white, the outer feathers broadly notched with white for their entire extent, the ends of these feathers being white barred across with blue; crown of head and nape white, broadly streaked with dark brown; lores white, with narrow brown shaft-streaks; round the hind neck a collar of pure white; cheeks, sides of neck, and entire under surface of the body pure white, the flanks and under wing-coverts with a few obscure zigzag lines of brown; thighs thickly barred with brown. Total length 17 inches, culmen 3·2, wing 8·05, tail 3·25, tarsus 1·05.

Another bird, marked by Dr. James as a male, but which I should take to be a young female, is more buff underneath, with remains of dusky edgings to the feathers, the throat whiter; on the upper surface the brown colour of the back is paler, with remains of dusky brown darker bars across the feathers; the white collar has also remains of brown edgings; upper tail-coverts and tail deep tawny red, barred across with blue, the ends of the tail-feathers white, much broader on the outer ones. Total length 17·7 inches, culmen 2·75, wing 8·2, tail 5·75, tarsus 1.

This species seems to be very fairly distinguishable from the other Laughing Kingfishers, being uniform below. The other characters mentioned by Count Salvadori in his original description are not of great value, the size being very variable, and the breadth of the stripes on the head depending upon age.

18. Dacelo gaudichaudi.—Sauromarptis gaudichaudi, *Salvad. & D'Albert. t. c.* p. 816; *Salvad. t. c.* p. 15.

a, ♂. Nicura, December 1875.

A male with blue tail. Total length 11·2 inches, culmen 1·95, wing 5·15, tail 3·95, tarsus 0·55.

19. Melidora collaris, sp. n.

M. similis *M. macrorhinæ*, sed torque collari postico albo distinguendus. Long. tot. 10·3, culmen 1·85, alæ 4·7, caudæ 3·6, tarsi 0·8.

a, ♂. Adult, no label. *b*, ♀. Low Aleya, Feb. 1876. Iris dark hazel; bill black; feet and tarsi pale yellow. *c*, ♀. Mainland of S.E. Papua, Feb. 29, 1876.

General colour above black; the feathers of the forehead mi-

nutely tipped with ochre-yellow, some of the plumes on the crown with verditer-blue, those of the nape with tiny spots of ochre; a line from the base of the nostril to above the fore part of the eye whitish, with a bluish tinge; feathers round the eye black; ear-coverts fulvous, the feathers edged with black, a broad streak of which runs along the cheeks; sides of neck and a collar round the hind neck white; back brownish black, largely spotted with ochre, somewhat shaded with greenish, the feathers being all tipped with this colour; wing-coverts coloured like the back, the greater series rich ochre at their tips; quills brown, the secondaries edged with rufous brown; lower back, rump, and upper tail-coverts dark brown, tipped with ochre; tail-feathers brown, obscurely edged with greenish and tipped with dull ochre; entire under surface of body buffy white, including the under wing-coverts; sides of body brown, tipped with reddish ochre.

Fam. Bucerotidæ.

20. Rhytidoceros ruficollis.—R. ruficollis (*V.*); *Salvad. t. c.* p. 19.

a, b. Aleya, March 1876.

A pair of young birds in fully adult plumage.

Fam. Caprimulgidæ.

21. Caprimulgus macrurus.—C. macrurus, *Horsf.*; *Salvad. t. c.* p. 23.

a. Yule Island, April 1876. Iris very dark, cornea very convex and projecting; bill black; feet and tarsi dark lead-colour.

22. Ægotheles bennetti.—Æ. bennetti, *Salvad. & D'Albert. Ann. Mus. Civ. Genov.* vii. p. 817; *Salvad. loc. cit.* ix. p. 23.

a, b. Aleya, April 1876. Eyes dark hazel; feet and tarsi almost white.

General colour above grisly brown, minutely vermiculated with greyish white; the head blacker than the back, a few feathers here and there vermiculated in the same manner with white, the markings on the hinder neck somewhat more coarsely indicated and marking a faint collar; wing-coverts exactly resembling the back; quills nearly uniform dark brown, faintly notched with greyish white on the outer web, the secondaries minutely vermiculated and resembling the rest of the back; tail blackish, with remains of ten faintly indicated bars of greyish white, the bars vermiculated and of unequal width; rictal bristles black, greyish white at

base; ear-coverts and cheeks black, obscurely barred across with brown; under surface of body blackish brown, coarsely vermiculated with white in transverse bars, these white bars becoming broader on the breast; the abdomen pure white, with a few remains of brown zigzag bars; sides of body and thighs blackish, vermiculated with white bars like the breast; under tail-coverts white, with narrow dusky brown transverse bars; under wing-coverts blackish, the innermost and the axillaries barred with white. Total length 9·5 inches, culmen 0·55, wing 4·65, tail 4·3, tarsus 0·7.

This seems to be a very well-pronounced species. It differs from all the other species that I have seen in its blackish colour, especially about the cheeks, which are black, with only a few transverse light bars; the bands on the tail also are very few in number, being only *nine*.

In examining the species of *Ægotheles* in the British Museum, I must say that they seem to be at present imperfectly characterized. Mr. Gould's figure of *Æ. leucogaster*, for instance, is figured with nine bands, whereas all our specimens have at least twelve or even thirteen bands. In South Australia there appears to be a species, not well discriminated, with dark brown ear-coverts, minutely barred with dull white. This form seems not to have been represented in Mr. Gould's work.

Order PASSERES.

Fam. Pittidæ.

23. Pitta novæ guineæ.—P. novæ guineæ, *Müll. & Schl.*; *Salvad. t. c.* p. 37.

a, ♂. Aleya, April 1875. Total length 6·3 inches, culmen 0·9, wing 4·1, tail 1·3, tarsus 1·45.

b. Aleya, April 1875. Eyes dark brown; bill entirely black; feet and tarsi dark slate-colour.

Fam. Turdidæ.

24. Cisticola ruficeps.—Cisticola, sp., *Salvad. t. c.* p. 35.

a, *b*, ♂. Yule Island, November 1875.

c, *d*, ♀. Yule Island, December 1875.

25. Malurus alboscapulatus.—M. alboscapulatus, *Meyer*; *Salvadori, t. c.* p. 36; *Gould, B. N. Guin.* pt. iv.—M. naimii, *Salvad. & D'Albert. t. c.* p. 827.

a, ♂. Nicura, Dec. 1875. Total length 4·3 inches, culmen 0·55, wing 1·8, tail 1·6, tarsus 0·8.

Fam. CINNYRIDÆ.

26. CINNYRIS FRENATUS.—Cyrtostomus frenatus (*S. Müll.*); *Salvad. & D'Albert. t. c.* p. 825; *Salvad. t. c.* p. 30.—Cinnyris frenatus, *Shelley, Monogr. Cinnyr.* pt. iii.

a, ♀. S.E. New Guinea.

Fam. MELIPHAGIDÆ.

27. GLYCIPHILA MODESTA, *Gray, P. Z. S.* 1858, p. 174.

a, ♂. Mainland of South-east Papua, Dec. 1875.

I have compared the specimen sent with the type from Aru Islands in the British Museum, and can find no specific difference.

Fam. MUSCICAPIDÆ.

28. TODOPSIS BONAPARTII.—Todopsis, sp., *Salvad. Ann. Mus. Civic. Genov.* ix. p. 19.

a. Mainland of New Guinea; east of Yule Island, Feb. 1876. Inhabits clumps of trees and shrubs in the midst of scrub.

b, ♂. Mainland of New Guinea, eight miles from Yule Island, Nov. 1875.

The specimens above named so closely resemble *T. bonapartii* of the Aru Islands that they seem to be specifically identical; the shade of blue above is the least bit more purple; but beyond that I can see no differences whatever.

29. PIEZORHYNCHUS NITIDUS.

a, ♀ ♂. Yule Island, Nov. 1874, April 1876.

30. ARSES TELESCOPHTHALMUS.—A. telescophthalmus (*Garn.*); *Salvad. & D'Albert. t. c.* p. 819; *Salvad. t. c.* p. 18.

a, ♂. Nicura, Dec. 1876.

b. Nicura. Eyes very dark brown, surrounded by a disk of light blue; bill pale blue at base, lighter at tip; feet and tarsi dark leaden colour.

c, ♀. Mainland, S.E. Papua, Feb. 29, 1875.

Fam. Laniidæ.

31. Pachycephala, sp.

a. Aleya, April 1876. Eyes very dark; bill entirely black; feet and tarsi lead-colour.

A single skin of a *Pachycephala* close to *P. griseiceps*, with the same dark head, and probably identical with the latter, though it differs slightly in the coloration of the buff breast.

32. Cracticus cassicus.—C. cassicus (*Bodd.*); *Salvad. & D'Albert. t. c.* p. 823; *Salvad. t. c.* p. 30; *Sharpe*, anteà, p. 82.

a, b. Aleya, April 1876.

33. Cracticus mentalis.—C. mentalis, *Salvad. & D'Albert. t. c.* p. 28.

a, ♂. juv. Nicura, Dec. 1875.

This species is a perfectly distinct one. The specimen sent by Dr. James is in intermediate plumage, just putting on the adult black-and-white dress.

Fam. Campephagidæ.

34. Edoliosoma melas.—E. melas (*S. Müll.*); *Salvad. & D'Albert. t. c.* p. 821; *Salvad. t. c.* p. 27.

a. Aleya, April 1876. Iris dark brown, almost black; bill, feet, and tarsi black.

Fam. Prionopidæ.

35. Rectes ferruginea.—R. ferruginea, *Bp.*; *Salvad. t. c.* p. 30.

a. Aleya, April 1876. Iris white; bill black; feet pale lead-colour.

b, ♀. Nicura, Dec. 1875.

Fam. Paradisiidæ.

36. Manucodia atra.—M. atra (*Less.*); *Salvad. & D'Albert. t. c.* p. 828; *Salvad. t. c.* p. 40.

a, ♂. Yule Island, April 1876. Total length 15·5 inches, culmen 1·65, wing 7·35, tail 6·5, tarsus 1·65.

b, ♂. Aleya, April 1876. Total length 15·7 inches, culmen 1·6, wing 7·7, tail 7·0, tarsus 1·65.

c, ♂. Mainland of S.E. Papua, Jan. 1876. Total length 16 inches, culmen 1·55, wing 7·7, tail 6·9, tarsus 1·65.

37. Paradisea raggiana.—P. raggiana, *Scl.*; *Salvad. & D'Albert. t. c.* p. 829; *Salvad. t. c.* p. 33.

a, ♂ juv. Aleya, April 1876.

b, ♀ ad. Aleya, April 1876.

Fam. Corvidæ.

38. Corone orru, *Müll.*; *Sharpe, Cat. B.* iii. p. 45.

a, ♂. Yule Island, Nov. 1875. Total length 18·5 inches, culmen 2·5, wing 12·35, tail 7·3, tarsus 2·3.

Fam. Oriolidæ.

39. Oriolus striatus.—Mimeta striata (*Q. & G.*); *Salvad. & D'Albert. t. c.* p. 828; *Salvad. t. c.* p. 39.—Oriolus striatus, *Sharpe*, anteà, p. 82.

a, ♀. Port Moresby, Nov. 1876.

Fam. Sturnidæ.

40. Calornis viridescens, *Gray*; *Sharpe, Ibis*, 1876, p. 47.—C. metallica, *Salvad. & D'Albert. t. c.* p. 827; *Salvad. t. c.* p. 38.

a, ♂. Yule Island, Nov. 1874.

Count Salvadori identifies the Yule-Island bird with *C. metallica*; but it agrees better with *C. viridescens*, with a Dorey specimen of which I have compared it; and it agrees with the latter in wanting the purple shade upon the flank so conspicuous in the true *C. metallica*.

41. Eulabes dumonti.—Mino dumonti, *Less.*; *Salvad. & D'Albert. t. c.* p. 328; *Salvad. t. c.* p. 39.—Eulabes dumonti, *Sharpe*, anteà, p. 82.

a, ♀. Aleya.

Order COLUMBÆ.

Fam. Columbidæ.

42. Goura albertisii.—G. scheepmakeri, *Salvad. & D'Albert. Ann. Mus. Civ. Genov.* vii. p. 797 (*nec Finsch*).—G. albertisii, *Salvad. Att. R. Acc. Torino*, xi. pp. 627, 680, var. vii.

a–e. Mainland of South-east Papua, Feb. 1873.

Five specimens of this fine Pigeon were sent. I give a detailed description of the species, which has not been sent to England before, and I add an account of a fine individual.

Adult. General colour above greyish blue, rather lighter on

the upper tail-coverts; tail blue, with a broad terminal band of bluish white; wing-coverts greyish blue like the back, the greater series milky white tipped with maroon, forming a large alar speculum, the outermost and innermost of the greater series blue tipped with maroon; quills dark greyish blue, deeper on the outer web; head with the usual enormous crest, many of the long crest-plumes being bluish white at their tips, imparting a silvery appearance; crown of head and sides of face rather clearer blue than the back, the feathers in front of and round the eye, as well as the fore part of the cheeks, black; throat and fore neck blue, the latter somewhat purplish; rest of under surface of body rich maroon; the lower abdomen, vent, and under tail-coverts greyish blue, as also the under wing-coverts and lower surface of the quills. Total length 31 inches, wing 15·6, tail 11·0, tarsus 3·55.

Count Salvadori is, in my opinion, quite right in keeping this fine Pigeon distinct from *G. scheepmakeri* of Finsch, as the whitish tips to the crest-feathers, the maroon tips to the specular coverts of the wing, and the absence of a black band along the upper edge of the alar speculum present characters which differ so strikingly from *G. scheepmakeri*, that it is impossible to believe that they can be identical.

43. PHLOGŒNAS JOBIENSIS.—Chalcophaps jobiensis, *Meyer.*—C. margarethæ, *Salvad. & D'Albert. t. c.* p. 836; *Salvad. t. c.* p. 44.

a. Adult without label.

b. Mainland of S.E. Papua, Feb. 29, 1876.

44. CHALCOPHAPS CHRYSOCHLORA.—C. chrysochlora (*Wagler*); *Salvad. & D'Albert. t. c.* p. 836; *Salvad. t. c.* p. 43.

a. Aleya, April 1875. Eyes dark brown; feet and tarsi colour of recent muscular tissue. Total length 10 inches, culmen 0·85, wing 5·9, tail 3·75, tarsus 0·9.

b. Mainland of S.E. Papua, Feb. 29, 1876. Total length 10·5 inches, culmen 0·85, wing 6·1, tail 3·6, tarsus 0·85.

Fam. CARPOPHAGIDÆ.

45. CARPOPHAGA PINON.—C. pinon (*Q. & G.*); *Salvad. t. c.* p. 41.

a. Mainland to the east of Yule Island, Feb. 1876.

46. CARPOPHAGA MUELLERI.—C. muelleri, *Temm.*; *Salvad. t. c.* p. 41.

a, ♂. Mainland of S.E. New Guinea, about eight miles from Yule Island, Nov. 1875.

Found also by D'Albertis on the Fly river. The present specimen measures—total length 17 inches, culmen 1·1, wing 8·85, tail 6·5, tarsus 1·15.

47. Ptilonopus coronulatus.—P. coronulatus, *Gray*; *Salvad. & D'Albert. t. c.* p. 833; *Salvad. t. c.* p. 42.

a. South-east Papua. Total length 8·5 inches, culmen 0·55, wing 4·4, tail 2·65, tarsus 0·8.

b. Aleya, April 1876. Iris deep red; bill light brown; feet and tarsi colour of recent muscle. Total length 8·3 inches, culmen 0·55, wing 4·6, tail 2·61, tarsus 0·8.

c. Aleya, April 1876.

Order GRALLÆ.

Fam. Charadriidæ.

48. Squatarola helvetica (*L.*); *Gray, Hand-l. B.* iii. p. 13.

a, ♀. Yule Island, Nov. 1875.

The specimen is apparently an old bird in full winter plumage; at all events, it has no trace of the golden speckling which is characteristic of the young bird of the year.

49. Actitis hypoleucus (*L.*); *Gray, Hand-l. B.* iii. p. 46.

a, ♂. Yule Island, Dec. 1865.

The specimen sent is a male in nearly adult winter plumage, some few remains of immaturity being apparent in the mottlings on the wing-coverts.

50. Numenius cyanopus, *V.*; *Gray, Hand-l. B.* iii. p. 42.

a, ♂. Yule Island, Dec. 1875.

Total length 21 inches, culmen 6·3, wing 9·4, tail 5·9, tarsus 4·4.

Fam. Rallidæ.

51. Porphyrio melanopterus.—P. melanopterus (*Temm.*); *Salvad. t. c.* p. 48.

A specimen without indication of exact locality.

Fam. Ardeidæ.

52. Butorides javanica, *Horsf.*; *Gray, Hand-l. B.* iii. p. 31.

a, ♂. Yule Island, Dec. 1875.

Total length 18 inches, culmen 2·7, wing 7·25, tail 2·6, tarsus 1·9.

53. Tigrisoma heliosylos.—Botaurus heliosylos, *Less. Voy. Coq.* pl. 44; *Gray, Hand-l. B.* iii. p. 32.

Adult. General colour above black, transversely banded with deep ochre; crown of head entirely black, the nape also less distinctly banded with ochre; wing-coverts resembling the back; the edge of the wing white, forming a conspicuous patch; quills black, the primaries with a slaty-grey gloss, the ochreous cross bands being more broken and forming mottlings, paler and inclining to white on the inner web; lower portion of the back and rump creamy white, tinged with ochre on the upper tail-coverts, the longest of the latter being slaty black towards their tips, with oval spots and transverse bars of ochre; tail blackish, tipped with a narrow band of ochraceous, and crossed with seven other bands of the same colour, increasing to nine in number on the outer feather; cheeks and ear-coverts white, transversely barred with black; throat pure white, the lower part with a few wavy lines of dusky black; the fore neck and chest and ruff deep ochre, broadly banded across with black; rest of under surface of body uniform pale fawn-colour, shading off into white on the abdomen and under tail-coverts; under wing-coverts creamy white. Total length 30 inches, culmen 4·1, wing 13·8, tail 5·8, tarsus 4·2.

a. Mangroves of Aleya, March 1876.

The figure in the Atlas to the Voyage of the 'Coquille' is very bad, and does not do justice to this fine Bittern, being much too dull in colour and not showing the ochraceous colour of the underparts.

Order ANSERES.

Fam. Anatidæ.

54. Tadorna radjah, *Garn*; *Gray, Hand-l. B.* iii. p. 80.

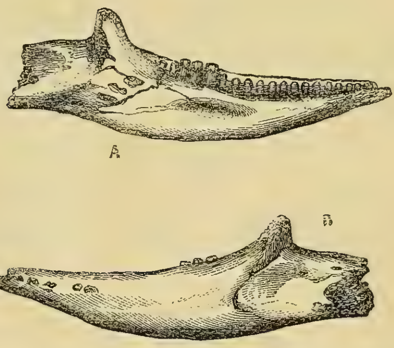
a, b, c. Nicura, Dec. 1875, March and April 1876.

Notice of two large Extinct Lizards, formerly inhabiting the Mascarene Islands. By Dr. A. Günther, F.R.S., F.L.S., Keeper of the Zoological Department, British Museum.

[Read March 15, 1877.]

I.—During an examination of remains of Birds and Chelonians from the Mauritius, especially the Mare aux Songes, the locality famous for its yield of Dodo-bones, I recognized in some fragments parts of the skeleton of a Lizard. They were not numerous, and consisted of a short fragment (with three teeth) of the maxilla, five fragments of the mandible, seven more or less perfect femurs, and portions of three humeri. Some had been collected by Mr. Edward Newton, to whom science is so much indebted for the better acquaintance with the extinct fauna of the Mascarenes, others by Mr. H. H. Slater, one of the naturalists accompanying the "Transit-of-Venus" Expedition.

Fig. 1.



Imperfect mandible of *Didosaurus mauritianus*, Günther, of natural size. A, the internal, and B, the external surface.

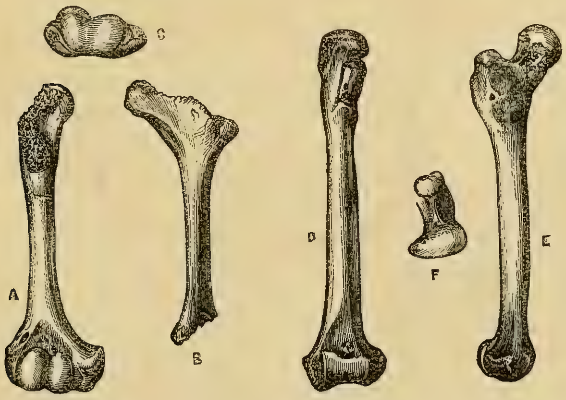
The mandible is an extremely solid and thick bone, with Pleurodont dentition, and with the alveolar edges far apart. In the least fragmentary example the entire dentary and part of the articular have been preserved; but the articulary surface has been broken away, so that we remain ignorant as to the form of the joint and the part behind it. The *dentary* is 37 millims. long, 12 millims. high behind, and 7 millims. thick in its middle. Its outer surface is very convex, smooth, perforated in its anterior half by a series of five foramina mentalia. It rapidly tapers in front, and is moderately deeply cleft behind for the reception of the articular

bone. The junction between the two bones is very close, without vacuity or foramen on the outer surface. The *splenial* consists of two pieces, the anterior fitting into the deep inner notch of the dentary, participating in the formation of the inner foramen; the posterior piece is small, and, barely touching the dentary, lies along the lower side of the articular; it terminates anteriorly in the perpendicular from the coronoid process. The *coronoid* is small, its process not quite vertical to the longitudinal axis of the mandible.

The *teeth* were closely set, small, about 24 in number; the anterior were probably conical and pointed, but the posterior, of which several are preserved, have very obtuse summits.

Shafts of three *humeri* have been preserved, one with the distal end complete, and another with a portion of the proximal extremity. This bone does not appear to differ from the type of other Pleurodont lizards. It is about 39 millims. long, with a thin and slightly compressed shaft, with the ulnar tuberosity dilated and much projecting, and with the radial margin compressed into

Fig. 2.



Different aspects of (A, B, C) the imperfect humerus and (D, E, F) a perfect femur of *Didosaurus mauritianus*. All of natural dimensions.

a sharp edge above the condyle; the supracondylar foramen perforates this sharp edge, just above the condyle. The distal extremity is 13½ millims. broad.

The specimens of *femur* are nearly of the same length (46 millims.), but some have a somewhat stouter shaft than others. The

is much stouter than that of the humerus. Also this bone shows no deviation from the ordinary Lacertian type.

The bones before us are sufficient to give an idea of the size of this Lizard; by comparing them with the skeletons of a Monitor and of a large Scincoid, I infer that the Lizard of Mauritius must have had a body of between 14 and 15 inches in length, the tail not included.

The question as to its affinities is much less easily answered, the peculiarities of the mandible being apparently rather generic, and not indicative of a family type, and the leg-bones being of too general a type to be of much use in the solution of the problem. The Pleurodont families which can come under our consideration are:—

1. The *Monitoridæ*, which are distinguished by a much smaller number of powerful teeth than we find in the Mauritian Lizard.

2. The *Teidæ* and *Lacertidæ* may be excluded, the former as being confined to the New World, the latter as being composed of species of small size.

3. Among the *Iguanidæ* all the genera approaching the Mauritian species in size are provided with notched teeth.

4. Thus, then, remain the families of *Zonuridæ* and *Scincidæ*, both of which are well represented in the tropical parts of Africa, Madagascar, and even the Mascarene Islands. The dentition of many of them closely resembles that of our Lizard, especially in the obtuse form of the crown of the tooth. Some, like *Zonurus*, *Gerrhosaurus*, and *Cyclodus*, approach the Mauritian form in size. In members of both these families there is a similar disproportion of thickness between humerus and femur, as in our Lizard. Thus it seems very probable that it will ultimately prove to belong to one of these families; but so much appears to be certain, from a comparison of its mandible with those of the other principal generic types, that it is sufficiently distinct to deserve being placed in a separate genus, for which I propose the name *Didosaurus mauritianus*.

II.—Mr. Slater collected in Rodriguez, with remains of the Solitaire and Tortoise, several bones which he recognized as the remains of a Lizard, possibly belonging to the family of Skinks. In my opinion it is a Geckoid Lizard, which, as far as the evidence before us goes, cannot be separated from the genus *Gecko*; but the species from Rodriguez appears to have attained a much larger size than *Gecko verus* (to which it is very similar), or than any

other Geckoid known. Referring, then, this Lizard to the genus mentioned, I concur in Mr. Slater's proposal of naming it after Mr. E. Newton,—*Gecko newtonii.*

The bones collected consist of two parietals, posterior half of right ramus of lower jaw, right humerus, right half of pelvis, five left and two right femurs, and therefore must have belonged to at least five individuals, of which the one indicated by the pelvis was the largest. In the following description these bones have been compared with the skeleton of a *Gecko verus*, the vertebral column of which is 100 millims. long (exclusive of the caudal vertebræ), and the skull 45 millims.

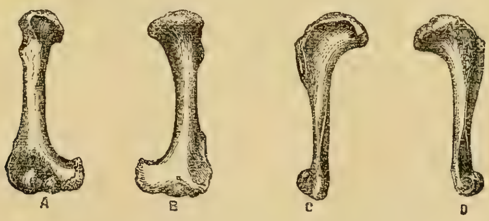
Fig. 3.

Parietal bone of *Gecko newtonii.* Upper aspect, and of natural size.

The *parietal* agrees in size and shape entirely with that of *G. verus*, in which the two long processes into which this bone bifurcates behind are separated by a large vacuity from the paroccipital. In *Phelsuma* (which genus is so well represented in these islands and on the coasts of this geographical region, and which might have been expected to occur in Rodriguez) the parietal has quite a different shape (*P. seychellense*), and its posterior processes are adpressed to the paroccipital.

The *articulary* piece of the mandible differs nowise from that of *G. verus*; like the latter it is produced behind the condyle into a hamate grooved process, which, however, is much more concave on its upper surface in the Rodriguez species than in *G. verus.*

Fig. 4.



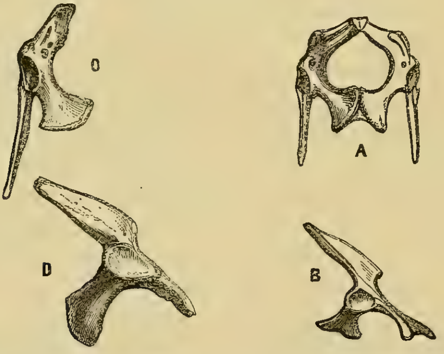
Humerus of *Gecko newtonii*, nat. size. A, anterior, B, posterior, C, ulnar, and D, radial aspects of bone.

The *humerus* offers a more striking difference from *G. verus* than the preceding bones; it is much stronger, and especially its extremities are comparatively much more dilated. Its head is transversely elongated, passing into a curved and projecting prominence, which answers to the ulnar tuberosity. The radial

crest is strongly developed, and does not extend beyond the proximal third of the length of the bone. The transverse diameter of the distal extremity is nearly rectangular to that of the proximal. The whole of this part of the bone is much dilated, particularly by a broad trenchant crest running along the radial border of the bone. Of the two condyles the radial one is much the more prominent one and projects towards the anterior side of the bone. In all these particulars *G. newtonii* resembles *G. verus*, all the ridges and prominences being, however, much more developed.

	G. verus. millims.	*G. newtonii.* millims.
Length of the humerus	$22\frac{1}{2}$	25
Least width of the shaft	2	3
Transverse diameter of proximal end	$5\frac{1}{2}$	9
Transverse diameter of distal end	$6\frac{1}{2}$	10

Fig. 5.



A. Inferior surface of the pelvis of *Gecko verus*. B. The outer aspect of the right os innominatum of the same animal. C. Lower surface of the right half of the pelvis of *G. newtonii*, and D, its exterior surface. All the figures are of natural size.

The *pelvis* and *femur* are so similar to those of *G. verus* that the accompanying figures and statements of measurements will suffice to give a perfect idea of those bones.

	G. verus. millims.	*G. newtonii.* millims.
Length of the os ilium (from acetabulum)	11	13
Greatest width of os ilium (from acetabulum)	4	$5\frac{1}{2}$
Length of os pubis (from acetabulum)	11	(injured)
Width of os pubis at its base	3	$5\frac{1}{2}$
Length of os ischii (from acetabulum)	$6\frac{1}{2}$	11

	G. newtonii. millims.	*G. verus.* millims.
Least width of os ischii	$2\frac{1}{2}$	11
Length of femur	26	30
Width in the middle	$1\frac{1}{2}$	3
Width of its lower extremity	$5\frac{1}{2}$	$7\frac{1}{2}$

Fig. 6.

The femur of *Gecko newtonii* in four different aspects and of natural dimension.

On *Myodes lemmus* in Norway. By ROBERT COLLETT, Conservator University Museum, Christiania, C.M.Z.S., &c. (Communicated by Dr. J. MURIE.)

[Read April 5, 1877.]

IN the previous year's publications of this Society are some articles by Mr. Duppa Crotch on the Norwegian Lemming (*Myodes lemmus*)*. As the habits and the economy of this mysterious little animal must always have considerable interest for any one who has the opportunity of observing it in the state of nature, I have considered that a few remarks on the same subject, being the result of personal experience, may be deemed worthy of notice, more especially as my personal observations in some respects differ from the statements made by Mr. Crotch. The following notes with some additions and abbreviations may be considered in the light of a partial translation of an article of mine in a memoir on the mammals of Norway, published in Christiania, March 1876†, and are here communicated by the desire of my friend Dr. Murie.

* 1. "On the Migration and Habits of the Norwegian Lemming," vol. xiii. p. 27 (Sept. 19, 1876). 2. "Additional Note relative to the Norwegian Lemming," vol. xiii. p. 83 (Dec. 15, 1876). 3. "Further Remarks on the Lemming," vol. xiii. p. 157 (Feb. 28, 1877).

† "Bemærkninger til Norges Pattedyrfauna," p. 18 (Nyt Magazin for Naturvidenskaberne, 22 B., Kristiania, 1876).

Myodes lemmus inhabits all the high fells of Norway from the southern branches of the Lemgfjeldene in Christiansand Stift to the North Cape and the Varangerfjord. South of the Arctic Circle its habitat is exclusively confined to the plateaux above the conifer region; in Tromsö Amt and in Finmarken it occurs on all suitable localities down to the level of the sea, and here, too, it is resident on the larger islands on the coast.

None of the eastern species and no constant race of the Lemming are found in Norway, and accidental varieties are exceedingly scarce. A few specimens of albinos are known.

Under ordinary circumstances it inhabits portions of the birch-regions on the fells, intermixed with dry juniper-covered ground and wet soil covered with the Dwarf Birch (*Betula nana*); in the daytime it remains hidden and is seldom observed, but is, however, never wanting on places of any extent with the above-mentioned natural qualifications.

The nest is found under a tussock, constructed of dry short straws, and is often, but not always, lined with hairs cast off by the animals themselves. The number of the young ones (excepting in years of migration) is generally five, sometimes only three, seldom seven to eight; and at least two sets are annually produced.

It feeds entirely on vegetable matter, especially grass-roots and straws, in winter bark of different species of Willow (*Salix*) and Birch (*Betula*); and it forms the staple food of the Snowy Owl (*Nyctea scandiaca*), the Rough-legged Buzzard (*Buteo lagopus*), the Short-eared Owl (*Asio accipitrinus*), the Arctic Fox (*Vulpes lagopus*), the Glutton (*Gulo borealis*), the Stoat (*Mustela erminea*), and, to some extent, Buffon's Skua (*Lestris parasitica*).

The wandering of the Lemmings, is a necessary consequence of their temporarily strong vitality together with an extreme migratory instinct, which is chiefly developed when they are in numbers. This tendency to appear in large numbers at irregular intervals of years is common to all the species of the subfamily Arvicolinæ; but in the present species (*Myodes lemmus*) it is probably more developed than in any other mammal.

During some years more families are produced than in others, without a migration consequently arising. Should the circumstances be favourable, and the families still more numerous, the increase in number causes smaller migrations, which every year take place here

and there, and is shown in the sporadic appearance of individuals down into the nearest valleys; and between these smaller and the true migrations every gradation is to be found.

This is a point that ought not be overlooked.

In some years the reproduction is still stronger, and the sudden collection of individuals of an animal that under ordinary circumstances seems to be nowhere very numerously distributed, but always keep themselves scattered on the larger plateaux, will naturally cause a movement of the masses towards the sides, so as again to make the balance even; and by the natural desire to wander possessed by this species (which is also to a certain extent shown by the allied species of Lemming, *M. schisticolor*, Lilljeb., and also in some of the other species of Arvicolinæ), these migrations very soon reach the borders of the plateaux, and subsequently spread over an area that is considerably larger than obtains in any other of the species under similar circumstances.

In cases where in two succeeding years the production of young has been excessive, the masses are incessantly pushed towards the sides of the fells; and the migration becomes an overrunning of the lower and far remote portions of the country, as the individuals gradually penetrate further in search of localities suitable to their habits (and which are capable of giving them a permanent subsistence), until they are stopped by the sea or destroyed in some other manner.

In the years of the great migrations the first families reared in the spring reproduce in the autumn of the same year, causing an over-population. This drives the individuals to wander down to the plains, often before they are full-grown. The next year the masses may increase in number to such an extent, that myriads continually move from the central plateaux and overrun the lowlands, where they join those that have previously arrived. Many pairs breed during the journey; they are therefore more numerous in the late summer, become less so in the autumn, die in immense masses in the winter, are seen, though sparingly, the next spring, and disappear gradually during the summer (the second year of their wandering). This stage of increasing and disappearing is the rule in many instances; but, as previously said, the migrations may be shorter as well as longer, and then not be finished before the third year from their starting from the fells.

In the years of migration the families follow each other quickly, and the set consists sometimes of nine, and not unusually of ten, young.

The greater number of those individuals that wander are young and born in one of the last two years; and I have observed that they chiefly consist of males, the number of females being regularly very small.

The migration is brought to a close by the death of the swarms, which is generally caused by an epizootic disease, the necessary consequence of over-population. As this disease develops itself on the high fells as well as on the lowlands, it cannot be caused by the unusual mode of living of the wanderers; for directly after these migrations the high fells seem almost devoid of inhabitants. The larger the masses, the higher is the mortality; and this is increased by the heat and want of drinking-water. During the great migrations one can easily witness the sudden deaths amongst the horde, many of their bodies appearing to be quite uninjured; though most of the specimens examined show the lower part of the back almost denuded of hairs, and the skin covered with small tubercles. These abrasions and pustules, in my opinion, are the result of a disease of the skin, and not due to the habit of backing up against a stone, or caused by their running into their underground holes, as has been commonly affirmed. No individual returns of its own will to the fells after it has once descended and moved any distance from the plateaux.

During the migrations they are devoured (besides by the mammals and birds of prey of the above-mentioned species that follow them down to the lowlands) chiefly by the Common Kestrel (*Falco tinnunculus*), the Common Buzzard (*Buteo vulgaris*), all the Owls (*Strigidæ*), and the other birds of prey, the Weasel (*Mustela nivalis*) and Fox (*Vulpes vulgaris*); further by Crows (*Corvidæ*) of different kinds, and in the northern parts of the country by species of Gulls and Skuas (*Larus* and *Lestris*); and it must be reckoned amongst the anomalies in the habits of the tame Ruminants that they (chiefly the cattle and goats) sometimes betake themselves to killing and eating the Lemmings. This is the case, too, with the wild Reindeer on the southern fells, and the same in Finmarken. Numbers are killed by dogs and cats; and men everywhere try with all their power to diminish their numbers.

The immediate reason for the large increase of Lemmings is doubtless owing to exceptional circumstances repeated for some

years, and consequently favouring their pairing and bringing up of their young; the result of which is far greater numbers of families and larger numbers of young in each set than in ordinary years. Parallel instances of these circumstances are clearly exhibited in the enormous increase in number of the larvæ of Lepidoptera in certain years; but I may add that it is apparently impossible to bring any direct proof of the true reason of that fact, and one can only form theories about the point. It is one of the many questions in the economy of nature that probably never will be solved; we only know that it is a fact.

It is, however, worthy of remark that these circumstances are always at the same time equally favourable to the increase of nearly allied species which are *quite independent of one another*. Thus in the years when *M. lemmus* migrates I have observed there is certain to be an increase above the normal number of one or more species of rats and mice (Muridæ),—in the southern parts of Norway chiefly the following Voles, *Arvicola gregarius*, *A. amphibius*, and *A. ratticeps*; in Finmark, *A. rufocanus*, *A. ratticeps*, and *A. rutilus*; further the Harvest-Mouse, *Mus sylvaticus*, and possibly other small Rodents. The increase, however, in these species never attains the magnitude that it does in *Myodes lemmus*; and none of these, as mentioned above, possess the migratory instinct in the same degree as the Lemming.

Furthermore, almost every "year of migration" and "breeding" that has taken place in the tracts below the Dovrefjeld and bordering the Trondhjemsfjord the Shrews (Soridæ), the Hare, and most of the Grouse tribe (Tetraonidæ) have at the same time been unusually numerous. Besides there are different other animals that are generally considered to a certain extent to depend upon *M. lemmus*, as they are found in larger numbers just in the years when the Lemmings are migrating, as it is supposed, in consequence of the superfluity of food; for instance, the two species of *Mustela*, *Vulpes lagopus*, *Nyctea scandiaca*, *Asio accipitrinus*, *Buteo lagopus*, and others. In my opinion this facility in obtaining superfluity of food is not the only or true reason for the increase of numbers of these animals.

I have elsewhere stated *, *Nyctea scandiaca* increased very numerously during the summer of 1872 in many districts where there

* "Remarks on the Ornithology of Northern Norway" (Forh. Vidensk. Selsk. Christiania, 1872, p. 223).

was no migration or hyperpopulation of the Lemming, just as much as it did in those districts which were full of them.

It will, I think, be rather difficult to state in what degree the climate or the seasons have to do with this increase of animals in certain years. Thus in 1862 the Blackcocks &c. (Tetraonidæ) in the southern parts of Norway were numerous to an extent that probably has not been the case in any year since; and a great migration of the Lemming took place in the autumn in the same localities: still it is a fact that the summer was proportionally cold and rainy, and therefore, as may be suggested, not particularly suitable to the bringing up of their young. The true ground for the periodical increase in numbers is doubtless a physiological necessity for the existence of the species, the reasons for which at present it is beyond our power to explain.

The wanderings take place in *the direction of the valleys*, and therefore can branch out from the plateaux in any direction. During migrations from the Dovre district the swarms wander northwards through the valleys of Sondre Trondhjems Amt, as much as southwards through Gudbrandsdalen and Osterdalen; from the district of Jotinsfjeldene and Langfjeldene the wanderings take the western direction to the innermost parts of Bergen Stift, or an eastern course, and push their way down the valleys of Valders, Hallingdal, and Nennedal. The most western valleys of Norway, as in Bergen Stift, are proportionally less frequently visited by them than the lowlands east of the high fells. From the High fells towards the Swedish frontier, under 62° to 63° N. lat., the wanderings branch out as much towards the districts bordering the Trondhjems fjord as the Swedish provinces Jemteland and Herjedalen, which in some years are covered with myriads of these animals that all penetrate towards the Baltic. It is seldom that the wandering flocks will cross a valley to reach a neighbouring fell; but sometimes they do: generally their course is somewhat irregular, but, on the whole, in the direction of the valley itself. They wander almost entirely in the night, and move quickly forwards. During the daytime they are, for the most part, resting or hidden amongst stones or the tussocks, though considerable numbers may be seen everywhere. Their temper and general habits are so well known that I may here omit to mention them.

During the seasons when they breed plentifully, the increase takes place abundantly on the islands, which are sometimes very small in extent; as is the case with many of the mountainous

islands of Lofoden and along the coast of Finmarken. On the islands the migrations soon cease when the sea is reached; during fine weather the animals will easily swim over fjords or lakes at least two English miles broad*.

Amongst the localities in Norway which are furthest distant from the summer dwellings of the Lemmings are Smaalenene (south-west of the Christianiafjord), the lowlands of Jadera (south of Stavanger), and the tracts bordering on the southern part of the lake Mjösen and on both sides of the Christianiafjord. But during certain years of migration these parts of the country are also covered with their swarms, and, on the whole, there perhaps is no attainable point of the country which has not during one or other year been visited by them. Each migration covers but a certain district, but never spreads simultaneously over the whole country.

The greatest migrations have generally taken place from some of the following great complex systems of fells:—

No. 1. From the plateaux of Langfjeldene and Jotinsfjeldene, sending swarms to the western portions of Christiania Stift, Christiansand Stift, and the adjacent valleys of Bergen Stift.

No. 2. From the plateaux of Dovre and the fells of Gudbrands-dalen and Osterdalen to the northern districts of Christiania Stift and the adjacent valleys of Trondhjem Stift.

No. 3. From the fells in Trondhjem Stift towards the Swedish frontier to the tracts bordering on the Trondhjemsfjord (and Swedish Nordland).

No. 4. From the fells in Nordland to greater or smaller portions of Nordland (and the neighbouring parts of Swedish Lapland).

No. 5. From the plateaux in the interior of Finmark to different parts of Finmark.

The smaller migrations, as above stated, may only include the neighbouring valleys which are adjacent to the plateaux. As districts which in later years have been particularly visited by their swarms, may be named (No. 3), for instance, the lowlands of Inderöen and other of the innermost parts of the Trondhjemsfjord,

* Here I may add a correction to a quotation by Mr. Crotch in one of his papers (p. 32). Mr. Crotch writes that "in November 1868 [quoted by Lillje-jeborg, *infra*] a ship sailed for fifteen hours through a swarm of Lemmings which extended as far over the Trondhjemsfjord as the eye could reach." The notice I gave Dr. Lilljeborg, and which is quite correctly quoted in his 'Fauna,' i p. 327 (Upsala, 1874), does not state fifteen hours, but a quarter of an hour; and it was not a sailing ship, but a steamer.

where, during the last ten years, often smaller or greater migrations have taken place, and where sometimes their visits have been of the most destructive nature.

I do not think it will be of any service for me to enter into detail in describing the different ways of each wandering, as far as it is known; for this would necessitate a somewhat extensive knowledge in the reader of the local topography of the country. I only here shortly mention the years of the *greater* migrations of which I have any information, this being, as will be seen, very incomplete until within the last twenty years.

1739–40. Hallingdal (from the plateau of No. 1).

1757. Trondhjemsfjorden (from No. 3).

1769–70. Osterdalen (from No. 2); at Kongsberg (from No. 1) Mr. Crotch mentions (p. 158) a wandering the same year.

1772. Söndmör, in Bergen Stift (from No. 1).

1774. Nordmör, in Bergen Stift, south to Satersdalen in Christiansand Stift (from No. 1). Most likely this and the migration of 1772 have been connected.

1780–81. Thelemarken, Eker, Hadeladed, and Christiansand Stift (from the south portions of No. 1).

1789–90. Christians Amt and about the same parts as the preceding wandering (from No. 1).

1816. Nordland (from No. 4).

1826. Bergen Stift (from No. 1).

1833–34. Thelemarken and Christiansand Stift (from No. 1). Mr. Crotch mentions (p. 158) a wandering the same year at Bosekop in Finmark (from No. 5).

In the last decades, I know of the following *great* migrations, all, except the first, from personal observation in the places themselves:—

1852–53. In the south of Finmark and the tracts of Tromsö (from No. 5).

1862–64. Southern parts of Christiania Stift (from No. 1).

1868–69. Trondhjem Stift and the northern portions of Christiania Stift (from Nos. 2 and 3).

1871. Eastern parts of Christiania Stift (from No. 1).

1872. Trondhjem Stift and the northern parts of Christiania Stift (from Nos. 2 and 3).

1875–76. Eastern and northern parts of Christiania Stift, Christiansand Stift, and north to Romsdalen (from Nos. 1 and 2).

1876. East Finmarken (from No. 5).

Description of *Acantharachna mirabilis*, a new Form of Ophiuridæ.

By Edgar A. Smith, F.Z.S., Zoological Department, British Museum. (Communicated by Dr. Murie, F.L.S.)

[Read March 1, 1877.]

(Plate XVIII.)

The specimen upon which the following new subgenus is founded was obtained by the British Museum many years ago (about the year 1840) from Mr. Cuming, by whom it was collected at the Philippine Islands. To it is attached his label, which runs thus, " Isle of Corregidor, Bay of Manilla, 7 fathoms—coarse sand and gravel."

This very remarkable species apparently partakes more of the character of the genus *Ophiomastix* than of any other. The soft skin covered with minute scales, the mouth-organs, and the character of the arm-plates and upper series of spines agree precisely with those of that genus; but the absence of tentacle-scales is perhaps sufficient to separate it subgenerically therefrom.

Genus Ophiomastix, *Muller & Troschel.*

Subgen. nov. Acantharachna*.

Discus cute molli, minute squamata, spinas paucas supra et infra gerente, indutus; scuta radialia nuda; dentes, papillæ dentales oralesque ut in *Ophiocomidis*; squamæ ambulacrales nullæ; rimæ genitales duæ; spinæ brachiales supremæ maximæ irregulariter positæ.

Acantharachna mirabilis, sp. nov.

Discus subpentagonalis, in medio inter brachia sinuatus, cute molli minute squamulata indutus; squamæ ad marginem inter scuta radialia imbricantes cæteris majores; superficies supra et infra spinis gracilibus paucis hic illic munita; scuta radialia parva, cuneiformia, longe distantia; brachia quinque inferne plana, supra convexa, diametrum disci octies paulo superantia; scutella oralia longiora quam latiora, ovalia, intus leviter acuminata; adoralia triangularia lateribus concavis, margines oralium amplectentia, intus inter se tangentia; papillæ orales crassæ, octo ad quemque oris angulum; papillæ dentales seriebus tribus, oralibus intimis similes; dentes —— ?; scuta brachialia inferiora fere æque longa ac lata, heptagonalia, marginibus aboralibus medio in angulum levem pro-

* ἄκανθα, a thorn, ἀράχνης, a spider. The name was suggested from the general appearance of a long thorny-legged spider.

ductis; scuta superiora hexagonalia, frequenter hic illic fracta, latiora quam longiora, ad latera acute angulata; scuta lateralia nec supra nec infra tangentia, extra valde prominentia; spinæ brachiales 2–3, duæ inferiores subæquales, longitudinem scuti inferioris paulo superantes, supremæ maximæ, crassæ, apice sæpe lobatæ, aliquanto scabræ, latitudinem brachii longitudine circiter æquantes, intervallis irregularibus positæ; color ubique lacteus. Diam. disci 16 mill., brachii 3.

Disk subpentagonal, sinuated in the middle of the margins between the rays, covered above and beneath with a soft minutely scaled skin, which is produced a little way up the arms; the scales along the lateral margins between the radial shields overlap one another and are much larger than those on the rest of the disk; on the upper and under surface are a number of small slender mobile spines widely and irregularly distributed. The radial shields are small, wedge-shaped, and very far apart, being separated by a space as wide as the arms; arms five, very long, flat beneath, and arched above and gradually tapering, eight or nine times as long as the diameter of the disk; oral shields longer than broad, oval, faintly pointed within; lateral mouth-shields triangular, with concave sides, embracing the sides of the oral shields and just meeting at their base; mouth-papillæ stout, four on each side of every angle, the outermost by far the largest, triangular and contiguous to the side mouth-shields and appearing like a supplementary lateral oral shield; the other three are in rotation smaller; tooth-papillæ in three rows, stout and like the inner mouth-papillæ; teeth — ?; tentacle-scale none; lower arm-plates about as long as broad, heptagonal, the two aboral margins sloping to a roundish angle, the two sides are rectilinear, the two inner lateral margins bounded by the side arm-plates, and the oral side concave, through the overlapping of the roundish angle or point of the preceding shield; upper arm-plates normally hexagonal, but frequently broken irregularly in one or more places, broader than long, the outer and inner sides equal and almost straight, the side margins almost equal and forming an acute angle between the lateral arm-plates.

The side arm-plates do not meet above or beneath, and are very prominent on the side remotest from the disk. The number of arm-spines is not constant on all the plates, some bearing two and others three. The two lower ones are subequal, not very acumi-

nate, and a trifle longer than a lower arm-plate. Uppermost spines placed at irregular intervals of two to five or even more plates; they are very large and stout compared with the others, frequently lobed at the end, somewhat scabrous, and about as long as the width of the arm. The colour is everywhere of a uniform cream-tint; the specimen perhaps is faded.

I cannot give the exact number of teeth, as there is but a single specimen, which would have to be mutilated too much in order to ascertain it; however, as far as can be seen, they appear to be few in number, stoutish, and truncate at the ends.

Under the microscope the arm-plates and spines are seen to be delicately granulous; and the apices of the largest spines are beset with most minute prickles.

Both the upper and lower arm-shields gradually become proportionally longer towards the end of the arms.

Ophiomastix flaccida, of Lyman, in many respects closely resembles this species; and since it has no tentacle-scale, it will come in this subgenus *Acantharachna*. The chief difference in the two species is in the covering of the disk. In *A. flaccida* it is "wholly covered by a smooth skin," whilst in *A. mirabilis* the covering is minutely squamose and displays small naked radial shields, and the margins of it are clothed with larger scales than those on the dorsal surface. The form of the lower arm-plates is different in the two species; the side mouth-shields and the colour also show certain differences.

DESCRIPTION OF PLATE XVIII.

Fig. 1. *Ophiomastix* (*Acantharachna*) *mirabilis*. View of upper surface, of natural size.

2. View of the lower surface, also of natural size.
3. The disk, seen from below, enlarged about twice nat. size, and showing the oral orifice with papillæ and also form of oral and anal shields.
4. Part of an arm seen from above, showing the form of the plates and the spines. About 3 diam.
5. Magnified view of a bifid brachial spine.
6. Apex of a terminally trifid brachial spine, also enlarged.

Geographical Distribution of Indian Freshwater Fishes.—Part II. The Siluridæ. By FRANCIS DAY, Esq., F.L.S.

[Read April 19, 1877.]

IN the first part of this paper[1] I gave an outline of the geographical distribution of the Acanthopterygian Freshwater fishes as existing in Sind, India, Burma, Ceylon, and the Andaman Islands. I now propose giving a similar sketch of the Sheat-fishes or Siluridæ[2], which form a large family amongst the Physostomi of Asia. Mostly scaleless, their mouths are provided with sensitive feelers, which, serving as organs of touch, assist them when seeking for their prey in turbid waters. Vision in such localities would be but of slight service; and, as might be anticipated, their eyes are comparatively small, whilst with advancing age these organs atrophy, not increasing so rapidly as the remainder of the body.

In addition to augmented facilities for feeling about in muddy water, they have a considerable development of the auditory organs, which doubtless must be of essential service.

The air-vessel or swim-bladder in fishes is found possessing two distinct functional offices. In the Acanthopterygians, destitute of a pneumatic duct, its use (excluding the question of its connexion with the internal ear) appears primarily to be a mechanical one, viz. for the purpose of maintaining a required level in the water and permitting the fish to rise or fall as desired.

In the majority of Carps (Cyprinina), in addition to the foregoing function, a pneumatic tube connects it with the pharynx, or upper portion of the alimentary canal, and also a chain of ossicles with the internal ear. In fact, it is employed both for hearing and flotation.

But in the Sheat-fishes (Siluridæ) the power of employing the air-vessel as a float appears to be subservient to that of hearing. Living, as they do, a life of ground feeders, this organ is more usefully restricted to acoustic purposes.

If we briefly consider where these fishes are found in Asia, it assists us in understanding this. Almost absent from the clear waters of the Red Sea[3], they commence being numerous at the

[1] Journal Linnean Society, Zoology, vol. xiii. p. 138.

[2] The Anacanthini, having no solely freshwater representatives, do not call for remark.

[3] *Arius thalassinus* and *Plotosus arab* are the only two species of Siluroids that have been recorded from the Red Sea.

more turbulent coasts of Beloochistan, at the mouths of the larger rivers and marine mud-flats off Sind and India, more especially Bengal and Burma. They are comparatively rare in the open sea; in fact at the Andamans they become scarce, except such species as reside where small streams empty themselves into muddy creeks. On the other hand, in the turbid sea near Moulmein and amongst the islands of the Mergui archipelago they abound.

In short, they resort to muddy waters; and in such places their feelers permit them to move about with ease, whilst their organs of hearing enable them to ascertain the vicinity of any enemy or the approach of some incautious prey.

We perceive the same thing amongst those inhabiting the fresh; the larger and muddier the rivers the more are they resorted to by Siluroids. Siluroids are found from the sea-coast to the base of the Himalayas; but as they generally deposit their ova in the waters of the plains, and not (like many Carps) in the rivers of the Subhimalayan range, they very sensibly diminish on nearing the hills. Still one or two species of *Callichrous* and a *Macrones* find their way into the hill-waters, where an *Amblyceps* and *Silurus*, as well as the mountain-torrent genera of *Pseudecheneis*, *Glyptosternum*, *Euglyptosternum*, and *Exostoma* find a congenial home. Those genera which are almost exclusively found in hill-streams are provided with an adhesive apparatus on the thorax, which, enabling them to adhere to stones, prevents their being carried away by the stream. As might be anticipated, their barbels are short, whilst in all the air-vessel is more or less enclosed in bone.

Reverting again to the air-vessel, we find it in Siluroids in two ways. In the marine forms it has an outer thick fibrous layer, and is attached to the lower surface of the bodies and transverse processes of some of the anterior vertebræ, whilst from it a chain of ossicles passes to the internal ear. As, however, we proceed inland or towards mountains a difference occurs, and in many genera the air-vessel becomes partially or entirely surrounded by bone. This may be effected by a trumpet-shaped extension of the lateral processes of the first or second vertebra, or else by an expansion of the most posterior of the auditory ossicles; but in either case the chain of bones is continued to the internal ear. The majority of those forms which have the air-vessels enclosed in a bony capsule being adapted to a mountain-torrent life leads me to conjecture that such may have some connexion with sound;

certainly such an organ, being almost incapable of expansion, would scarcely be of much service as a compressible float.

These fishes are generally well provided with weapons of offence[1] or defence; they have mostly strong dorsal and pectoral spines, often serrated and with which they can inflict dangerous wounds. This spinal armature is invariable in the marine and estuary forms, as there they are most called upon to resort to offensive or defensive measures. The auditory apparatus is more developed in the inland genera, where, instead of having to battle for their existence, they become the tyrants of the waters they inhabit.

Whether any East-Indian genera of Siluroids possess a distinct poison-apparatus or gland connected by a duct to a wound-inflicting-spine has not as yet been proved. But that most dangerous symptoms are occasioned by their dorsal and pectoral spines, is known not only to men but even to the lower animals.

On June 18th, 1869, I was present in Burma when the famous *Een-gay-gyee* lake was fished, which is done by placing a stationary weir across the water (which is a sort of river encircling an island); and a movable one is with great labour dragged up to it by large gangs of men, whose labours are continued for months. The final point had now been reached; and all round this enclosure nets were reared to about ten feet above the water to prevent the fish escaping[2], and which the captives, wild with alarm, were trying to

[1] Laws have been enacted in several countries rendering it penal to bring these fishes to the markets for sale with their spines intact. Omitting any consideration of the state of the health of the individual wounded, we find fishes occasion three distinct varieties of wounds:—

a. Punctured wounds inflicted by a spine destitute of a poison-gland or duct, as seen in the European Weevils (*Trachinus*) or the East-Indian *Polyacanthus*. But as distinct irritating effects extend for some distance from the wounded spot, and remain for a considerable period, it seems questionable whether some mucous or other substance causing these symptoms may not be present on the spine.

β. Lacerated wounds, such as may be caused by the dorsal or pectoral spines of Siluroids or the serrated spine on the tail of the Skates. In these cases also irritation may be occasioned by some mucous secretion.

γ. Poisoned wounds. The Siluroid *Thalassophryne* has been shown to have a distinct poison-gland leading up a canal existing in a serrated spine by which the wound is inflicted (Günther, P. Z. S. 1864, p. 155). The *Synanceia verrucosa* has also been shown to have a tube at each of its dorsal spines and a poison-gland at its base. The wounds, as might be anticipated, are very venomous.

[2] Salt for preserving them had not arrived.

jump over. Pelicans and cormorants were numerous and constantly devouring the spoil; but it was very curious to see how when fish sprang out of the water the birds opened their mouths, but sheered off to a respectful distance, evidently dreading the fall of the spined Siluroids on themselves. I have taken the sea-snake (*Enhydrina*) with the pectoral spine of an *Arius* projecting through its integuments from the intestinal canal.

There is also a difference perceptible in the manner in which some at least of Siluroids deposit their eggs. The marine and estuary *Arius* and its allies have large eggs; and as they are frequently found in the mouths of the males, whilst their intestines are destitute of food, it appears probable that they either carry them about in that manner for protection until hatched, or else remove them from what they consider to be a dangerous locality[1]. In the freshwater species, on the contrary, we find the eggs very small; and the difference between those of the marine *Arius* and freshwater *Macrones* is very striking.

Regarding their respiration, I have already pointed out[2] that some, as *Saccobranchus* and *Clarias*, are truly amphibious, whereas I have no reason for believing that any of the other genera of Siluroids in India are so.

Amongst the Siluridæ, we know of thirty-one genera represented in India, Burma, and Ceylon; and of these we have twenty-six wholly or entirely confined to fresh water.

1. MACRONES[3], *Dumeril.* The fishes of which this extensive genus is comprised extend through most parts of Asia, more especially in the tropics. They are numerous in the fresh waters of Sind, the whole of Hindustan, Ceylon, and Burma, and are common through Siam to the Malay archipelago.

2. LIOCASSIS[4], *Bleeker.* Eastern Bengal and Assam to the Malay archipelago.

3. ERETHISTES[5], *Müller & Henle.* These small fishes are found from Orissa and Bengal, through Assam and Burma. M'Clelland also records a species from Chusan.

4. RITA[6], *Bleeker.* These fishes are found in the Indus and

[1] See paper by Prof. Turner, Camb. Jour. of Anat. and Zool. vol. i. p. 78.

[2] Journal Linn. Soc. Zool. vol. xiii. No. 68, p. 198.

[3] Includes:—*Bagrus*, pt., Cuvier & Valenciennes; *Hypselobagrus*, *Hemibagrus*, *Pseudobagrus*, and *Aspidobagrus*, Bleeker.

[4] Includes *Rama*, Bleeker; and see note to species.

[5] Includes *Hara*, Blyth.

[6] Includes *Gogrius*, Day.

its affluents, in the Jumna and Ganges, also in the Irawaddi in Burma to far above Mandalay.

5. PANGASIUS[1], *Cuvier & Valenciennes.* Larger rivers and estuaries of India and Burma to the Malay archipelago.

6. PSEUDEUTROPIUS[2], *Bleeker.* These fishes are common in the waters of Sind, India, Ceylon, and Burma, but at the Malay archipelago appear to be represented by a single species.

There is a very similar genus (*Eutropius*) separated from the foregoing owing to the position of its two pairs of mandibular barbels, the pair on either side being anterior to the inner ones, whereas in *Pseudeutropius* they arise on a transverse line.

All authenticated specimens of *Eutropius* are African; but one species, said to have come from India, was purchased in Liverpool and is in the British Museum. There is no other record of this one having been found in Africa, neither has it been brought from India by any other party; and, until rediscovered, the land which gave it birth may fairly be considered an open question.

Pseudeutropius, on the contrary, has not been found in Africa; and I believe that our present knowledge only warrants our considering the one genus African, the other Asiatic. I should mention here that a fossil fish has been discovered in the tertiary formation at Sumatra (deficient of its head), and has been assigned to this genus (Günther, Geol. Mag., Oct. 1876).

7. OLYRA[3], *M'Clelland.* These small fishes appear to be restricted, so far as we know, to the hills in Upper Assam and Pegu.

8. CALLICHROUS[4], *Hamilton Buchanan.* Sind, India, Ceylon, Burma to the Malay archipelago and China.

9. WALLAGO, *Bleeker.* Sind, India, Ceylon, Burma to the Malay archipelago.

10. SILURUS[5], *Artedi.* From Eastern Europe and Turkestan, along the Himalayas to Akyab, Tenasserim, Cochin China, the Malay archipelago, and China; also along the hills of the Malabar coast of India.

[1] Includes *Pseudopangasius* and *Helicophagus*, Bleeker.

[2] Includes *Clupisoma*, Swainson, *Schilbeichthys*, Bleeker.

[3] Includes *Branchiosteus*, Gill.

[4] Includes:—*Ompok*, Lacépède; *Kryptopterus, Kryptopterichthys, Micronema, Phalacronotus, Hemisilurus, Silurodes, Pseudosilurus*, and *Silurichthys*, Bleeker; *Pterocryptes*, Peters.

Parasilurus, pt., Bleeker.

11. CHACA, *Cuvier & Valenciennes*. Bengal, Assam, and Burma to the Malay archipelago.

12. CLARIAS [1], *Gronovius*. These amphibious fishes are found throughout Africa and Western Asia to India, Ceylon, Burma, Siam, the Malay archipelago, Hongkong, the Philippines, and beyond.

A nearly allied genus (*Heterobranchus*) is found in Africa; and Bleeker has discovered a species of it in the Malay archipelago.

13. SACCOBRANCHUS [2], *Cuvier & Valenciennes*. These are likewise amphibious fishes, but not found in Africa. They frequent the fresh waters of India, Ceylon, Burmah, to Cochin China, but have not been recorded from the Malay archipelago.

14. SILUNDIA, *Cuvier & Valenciennes*. These fishes frequent the large rivers of India and Burma.

15. AILIA, *Gray*. Sind, the larger rivers of the Punjab, N.W. Provinces, Bengal, Orissa, and Assam.

16. AILIICHTHYS, *Day*. Indus and Punjab rivers, also Ganges and Jumna.

17. EUTROPIICHTHYS, *Bleeker*. Large rivers of India and Burma.

18. AMBLYCEPS, *Blyth*. Himalayas, valley of the Ganges, Eastern Bengal, to Burma.

19. SISOR, *Hamilton Buchanan*. Indus, Jumna, and Ganges rivers.

20. GAGATA [3], *Bleeker*. Sind, India (except its northern portion), Assam, and Burma.

21. NANGRA, *Day*. Sind, Deccan, N.W. Provinces, and Bengal.

22. BAGARIUS, *Cuv. & Valenciennes*. Larger rivers of India and Burma to Java.

23. GLYPTOSTERNUM [4], *M'Clelland*. Hill-streams and rapid rivers of the plains of the Himalayan region, and India, to the Malay archipelago. Fishes of this genus are provided with an adhesive apparatus consisting of longitudinal folds of skin and placed between the bases of the pectoral fins on the thorax.

24. EUGLYPTOSTERNUM [5], *Bleeker*. Syria, upper portions of

[1] Includes:—*Macropteronotus*, Lacépède; *Cossyphus* and *Phagorus*, M'Clelland.

[2] Includes *Heteropneustes*, Müller.

[3] Includes:—*Batassio*, pt., Blyth; *Callomystax*, Günther.

[4] Includes *Glyptothorax*, Blyth.

[5] Includes *Aglyptosternon*, Bleeker.

the Jumna, and Upper Assam. This genus possesses an adhesive thoracic sucker, as in the last.

25. PSEUDECHENEIS, *M'Clelland*. Head waters of the Ganges and on the Himalayas, also the Khasya hills. Fishes of this genus have a very well-developed adhesive sucker on the chest, composed of transverse folds of skin.

26. EXOSTOMA[1], *Blyth*. Head waters of Indus, along the Himalayas and hilly districts to Assam, Pegu, Tenasserim, and the confines of China. Although these fishes have no adhesive sucker on their tuberculated chest, it is flattened, while the pectoral and ventral fins are evidently adapted for adhesion.

Examining the foregoing genera composing the freshwater Siluroids of India, we find that, of the 26 genera, 10 reach the Malay archipelago, 6 are restricted to India on the west, 6 to India and Burma, whilst *Erethistes* extends to China, *Saccobranchus* to Cochin China; and *Clarias* ranges from Africa, through Syria and India, to the Malay archipelago and beyond.

In short, out of 26 genera, 11 have Malayan and Chinese representatives, whilst only 1 has African; and this genus is common to the Malay archipelago.

I will now follow out the geographical distribution of each species, so far as such have been as yet recorded or have fallen under my own observation.

Genus MACRONES.

1. MACRONES CHRYSEUS, *Day*. Rivers in Canara and Malabar.

2. M. AOR[2], *Hamilton Buchanan*. Throughout the fresh waters of Sind, India, Assam, and Burma.

3. M. SEENGHALA[3], *Sykes*. Sind, Salt range of Punjaub, the Jumna and Ganges rivers, certainly as low as Delhi; the Deccan and Kistna river to its termination.

4. M. BLYTHII[4], *Day*. Tenasserim.

5. M. GULIO[5], *Hamilton Buchanan*. This is the only Indian species of this genus recorded as from the sea; it frequents estu-

[1] Includes *Chimarrichthys*, Sauvage.

[2] Includes :—? *Bagrus aorinus*, Val.; *B. aorides*, Jerdon.

[3] Includes :—*Bagrus Lamarrii*, Cuv. & Val.; *B. aorellus*, Blyth.

[4] Includes *Batasio affinis*, Blyth.

[5] Includes :—*Bagrus albilabrus*, *fuscus*, *Birmannus*, and *abbreviatus*, Cuv. & Val.; *B. gulioides*, *melas*, *Schlegelii*, and *rhodopterygius*, Bleeker.

aries and tidal pieces of water as far as the Malay archipelago. Its ova are small, and like what obtain in the rest of the genus, and not similar to the large ova of the marine *Arius* and its allies.

6. M. PUNCTATUS, *Jerdon.* Bowany river at base of the Neilgherries in Madras.

7. M. CORSULA[1], *Hamilton Buchanan.* From Orissa, through Bengal and Assam.

8. M. MICROPHTHALMUS, *Day.* Burma, along the course of the Irrawaddi.

9. M. CAVASIUS[2], *Hamilton Buchanan.* From Sind, throughout India, Assam, and Burma.

10. M. TENGARA[3], *Hamilton Buchanan.* Northern India, Punjaub, and Assam.

11. M. OCULATUS, *Jerdon.* Malabar coast and Coimbatore district.

12. M. VITTATUS[4], *Bloch.* Sind, Indian Assam, Burma, Siam, and also Ceylon.

13. M. LEUCOPHASIS, *Blyth.* Rivers of Burma.

14. M. MONTANUS[5], *Jerdon.* Wynaad range of hills in Madras.

15. M. KELETIUS, *Cuv. & Val.* Madras and inland to Mysore and Coimbatore; also Ceylon.

16. M. MALABARICUS, *Day.* Malabar coast of India.

17. M. ARMATUS, *Day.* Malabar coast and western Ghauts.

18. M. BLEEKERI[6], *Day.* Sind, Jumna, Ganges, and Burma.

Of the foregoing 18 species of *Macrones*, 2 have barbels not longer than the head, one (No. 1) is restricted to the Malabar coast, the second (No. 4) to Tenasserim. In all of the others the feelers reach at least to the ventral fin.

The following shows their distribution :—3 Malabar and west-

[1] Includes :—*Pimelodus menoda,* Ham. Buch.; *Bagrus trachacanthus,* Cuv. & Val.

[2] Includes *Pimelodus seengtee,* Sykes.

[3] Includes :—*Pimelodus batasius,* Ham. Buch. (figure, not description); ? *P. anisurus,* M'Clelland.

[4] Includes :—*Pimelodus carcio,* Ham. Buch.; ? *P. indicus,* M'Clelland; *Bagrus affinis,* Jerdon.

[5] Includes ? *Bagrus agricolus,* Jerdon.

[6] Includes :—*Bagrus keletius,* Bleeker; ? *B. tengara,* var., Blyth.

ern Ghauts; 4 western Ghauts or their bases, or through Mysore to Madras; 3 Sind, India, Assam, and Burma (1 also in Ceylon); 1 Deccan, Jumna, and Ganges rivers; 1 Sind, Jumna, Ganges, and Burma; 1 Northern India and Assam; 1 Bengal, Orissa, and Assam; 2 Burma; 1 Tenasserim; 1 coasts of Sind, India, Ceylon, and Burma.

Thus, if we exclude the half-marine *Macrones gulio*, we find 7 restricted to Malabar and Madras; 1 to the Deccan, Jumna, and Indus; 4 Indus, Ganges, Jumna. Brahmaputra, and Burma rivers; 2 locally in Bengal and Assam; 3 Burma.

Genus Leiocassis.

1. L. rama[1], *Hamilton Buchanan.* Eastern Bengal and Assam.

Genus Erethistes.

1. E. hara[2], *Hamilton Buchanan.* Orissa, Bengal, Assam, and Burma.

2. E. conta[3], *Hamilton Buchanan.* Eastern Bengal, Assam, and Burma.

3. E. Jerdonii, *Day.* Sylhet.

4. E. elongata, *Day.* Naga hills.

These four species have a somewhat confined distribution, 2 extending from Orissa throughout Bengal, Assam, and Burma, and 2 being confined to the hills in the vicinity of Assam.

Genus Rita.

1. R. Buchanani[4], *Bleeker.* Indus, Jumna, and Ganges rivers and their affluents, Burma.

2. R. pavimentata[5], *Val.* Deccan and Kistna river to its termination.

3. R. chrysea, *Day.* Orissa.

4. R. hastata[6], *Val.* Deccan and Kistna river to its termination.

[1] Includes:—? *Pimelodus chandramara*, Ham. Buch.; *Silonia diaphina*, Swainson; *Rama Buchanani*, Bleeker.

[2] Includes:—*Erethistes pusillus*, Müller & Troschel; *Hara Buchanani*, Blyth.

[3] Includes *Hara filamentosa*, Blyth.

[4] Includes:—*Pimelodus rita*, Ham. Buch.; *Arius ritoides*, Cuv. & Val.; *Rita crucigera* (Owen), Günther.

[5] Includes:—*Phractocephalus gogra*, Sykes; *Gogrius Sykesii*, Day.

[6] Includes:—*Arius pumilus*, Val. (young); *Phractocephalus kuternee*, Sykes.

1 species is spread through the region of the Indus, Jumna, and Ganges rivers to Burma, 2 through the Deccan and Kistna river, and 1 appears to be restricted to Orissa.

Genus PANGASIUS.

1. P. BUCHANANI[1], *Cuvier & Valenciennes.* Large rivers of India, Assam, Burma, and perhaps the Malay archipelago.

Genus PSEUDEUTROPIUS.

1. P. GOONGWAREE[2], *Sykes.* Deccan, upper waters of Ganges and Jumna, Burma.

2. P. TAAKREE[3], *Sykes.* Rivers of the Deccan and the Jumna.

3. P. ACUTIROSTRIS, *Day.* Rivers of Burma.

4. P. MURIUS[4], *Hamilton Buchanan.* Rivers of Sind, Jumna, and rivers of Bengal and Orissa; also Assam.

5. P. SYKESII[5], *Jerdon.* Malabar coast of India.

6. P. ATHERINOIDES[6], *Bloch.* Sind, India (excluding the western coast and Assam).

7. P. GARUA[7], *Hamilton Buchanan.* Throughout the larger rivers of Sind, India (except its most southern portion and the western coast), Assam, and Burma.

Of the foregoing seven species, 1 is spread through the Indus, Jumna, and Ganges to Bengal, Orissa, and Assam; 1 the same, but continued to Burma; 1 Sind, India (excluding the western coast), and Assam; 1 Deccan, Ganges, and Jumna, also Burma; 1 locally in Malabar; 1 restricted to Burma; and 1 restricted to the Malabar coast.

Thus 2 Indian forms are found in Burma; 1 Burman form appears to be restricted to that country, but to be a representative of an Indian form which does not extend to Burma.

Genus OLYRA.

1. O. LONGICAUDA, *M'Clelland.* Khasya hills.

[1] Includes:—*Pimelodus pangasius*, Cuv. & Val.; ? *P. djambal*, Bleeker.

[2] Includes *Eutropius macrophthalmus*, Blyth.

[3] Includes *Pseudeutropius longimanus*, Günther.

[4] Includes:—*Pachypterns melanurus*, Swainson; ? *Pseudeutropius megalops*, Günther.

[5] Includes *Pseudeutropius Mitchelli*, Günther.

[6] Includes:—*Pimelodus anguis* and *urua*, Ham. Buch.; *Pachypterus trifasciatus*, Swainson; *Bagrus exodon*, Bleeker.

[7] Includes *Clupisoma argentata*, Swainson.

2. O. Burmanica, *Day.* Pegu hills.

3. O. laticeps, *M'Clelland.* Khasya hills.

2 of these species are locally restricted to Assam and 1 to Pegu.

Genus Callichrous.

1. C. gangeticus, *Peters.* Ganges.

2. C. sindensis, *Day.* River Indus.

3. C. bimaculatus[1], *Bloch.* Fresh waters of Sind, India, Ceylon, Assam, and Burma, to the Malay archipelago and beyond.

4. C. pabo[2], *Hamilton Buchanan*, Jumna and Ganges rivers, and Burma.

5. C. macrophthalmus[3], *Blyth.* Madras, Assam, and Burma.

6. C. malabaricus, *Cuvier & Valenciennes.* Malabar coast of India.

7. C. pabda[4], *Hamilton Buchanan.* Indus and its affluents, Ganges, Jumna, Brahmaputra, and also Orissa.

These 7 species have a peculiar distribution: 1 is found from Sind through India and Ceylon to the Malay archipelago and beyond; 1 Indus, Ganges, Jumna, and Brahmaputra to Burma; 1 Ganges and Jumna and to Burma; 1 Madras, Assam, and Burma; 1 locally to Sind; 1 Malabar; 1 Ganges.

Genus Wallago.

1. W. attu[5], *Bloch.* Throughout Sind, India, Ceylon, Assam, and Burma.

Genus Silurus.

1. S. Wynaadensis, *Day.* Western Ghauts of India.

2. S. afghana[6], *Günther.* From Afghanistan along the Himalayas to Darjeeling.

[1] Includes:—*Ompok siluroides*, Lacépède; *Silurus checkra, canius*, and *duda*, Ham. Buch.; *S. microcephalus* and *mysoricus*, Cuv. & Val.; *Callichrus immaculatus, nebulosus*, and *affinis*, Swainson; *Silurus indicus*, M'Clelland; *Schilbe pabo*, Sykes; *Phalacronotus siluroides*, Bleeker; *Callichrous ceylonensis*, Günther.

[2] Includes *Callichrous nigrescens*, Day. [3] Includes *Callichrous notatus*, Day.

[4] Includes:—*Silurus anastomus*, Cuv. & Val.; *S. lamghur*, Heckel; *Callichrus vittatus*, Swainson; *Cryptopterus latovittatus*, Playfair; *Callichrous Egertonii*, Day.

[5] Includes:—*Silurus boalis*, Hamilton Buchanan; *S. wallago* and *asotus*, Cuv. & Val.; *Callichrus macrostomus*, Swainson; *Silurus Mülleri*, Bleeker; *Wallagoo Russellii*, Bleeker.

[6] Includes *Silurus Dukai*, Day.

3. S. COCHINCHINENSIS[1], *Cuv. & Val.* Hills above Akyab, also Tenasserim to Cochin China.

Of these three species, 1 appears to be found along the Himalayas from Afghanistan to at least Darjeeling; 1 is spread from the hills above Akyab to Tenasserim and Cochin China; whilst the third is confined to the western Ghauts on the Malabar coast up to about 2500 feet elevation.

Genus CHACA.

1. C. LOPHIOIDES[2], *Cuvier & Valenciennes.* Ganges, Brahmaputra, and Irrawaddi rivers.

Genus CLARIAS.

1. C. TEYSMANNI[3], *Bleeker.* Ceylon, Java.

2. C. DUSSUMIERI[4], *Cuv. & Val.* Coasts of India and the Malay archipelago.

3. C. MAGUR[5], *Hamilton Buchanan.* Throughout India and Burma to the Malay archipelago.

4. C. ASSAMENSIS, *Day.* Assam.

Of the 4 species of *Clarias*, 1 is generally distributed through India and Burma to the Malay archipelago; 1 Malabar and Madras to the Malay archipelago; 1 Ceylon and the Malay archipelago; 1 restricted to Assam.

Genus SACCOBRANCHUS.

1. S. MICROPS, *Günther.* Ceylon.

2. S. FOSSILIS[6], *Bloch.* Fresh waters of Sind, India, Ceylon, Assam, Burma, and Cochin China.

Genus SILUNDIA.

1. S. SYKESII[7], *Day.* Rivers of Deccan and throughout the Kistna and Godavery.

[1] Includes *Silurichthys Berdmorei*, Blyth.

[2] Includes:—*Platystacus chaca*, Hamilton Buchanan; *Chaca Buchanani*, Günther.

[3] Includes ? *Clarias brachysoma*, Günther.

[4] Includes *Clarias melanosoma*, Bleeker.

[5] Includes:—*Silurus batrachus*, Bloch; *S. anguillaris*, Russell; *Clarias marpus* and *punctatus*, Cuv. & Val.

[6] Includes:—*Silurus singio*, Ham. Buch.; *S. laticeps* and *biserratus*, Swainson; *Saccobranchus microcephalus*, Günther.

[7] Includes ? *Ageneiosus childreni*, Sykes.

2. S. GANGETICA[1], *Cuv. & Val.* Larger rivers of India and Burma.

Of these two species, 1 appears to be restricted to the Deccan rivers, the other is spread through the larger rivers of India and Burma.

Genus AILIA.

1. A. COILA[2], *Hamilton Buchanan.* Sind, the large rivers of the Punjab, N.W. Provinces, Bengal, Orissa, and Assam.

Genus AILIICHTHYS.

1. A. PUNCTATA, *Day.* Indus, rivers of the Punjab, and upper portions of the Ganges and Jumna.

Genus EUTROPIICHTHYS.

1. E. VACHA[3], *Hamilton Buchanan.* From the Punjaub, through the large rivers of Sind, Bengal, and Orissa; whilst a variety (*E. Burmanicus*) is found in Burma.

Genus AMBLYCEPS.

1. A. MANGOIS[4], *Hamilton Buchanan.* Along the Himalayas commencing at the Punjaub, in the Jumna for some considerable distance from the hills, also through Burma to Moulmein.

Genus SISOR.

1. S. RHABDOPHORUS, *Hamilton Buchanan.* Indus, Ganges, and Jumna rivers, as low as Bengal and Behar.

Genus GAGATA.

1. G. CENIA[5], *Hamilton Buchanan.* Indus, Ganges, and Jumna rivers; also rivers of Orissa and Burma.

2. G. ITCHKEEA, *Sykes.* Rivers of the Deccan.

3. G. BATASIO, *Ham. Buch.* River Testa.

4. G. TENGANA, *Ham. Buch.* Assam.

[1] Includes ;—*Pimelodus silondia*, Ham. Buch.; *Silonia lurida*, Swainson.

[2] Includes :—*Silurus Cuvieri*, Gray; *Malapterus bengalensis*, Gray; *Acanthonotus Hardwickii*, Gray; *Ailia affinis*, Günther.

[3] Includes *Pachypterus punctatus*, Swainson.

[4] Includes :—*Amblyceps cæcutiens* and *A. tenuispinus*, Blyth; *Akysis Kurzii*, Day.

[5] Includes:—*Pimelodus gagata*, Ham. Buch.; *Gagatatypus*, Bleeker.

Genus Nangra.

1. N. Buchanani[1], Day. Indus, Ganges, and Jumna rivers.

2. N. punctata, Day. Sone river.

3. N. iridescens, Ham. Buch. North Bengal and Deccan.

Genus Bagarius.

1. B. Yarrellii[2], *Sykes*. Large rivers of Sind, India, and Burma to the Malay archipelago.

Genus Glyptosternum.

1. G. lonah[3], *Sykes*. Poona and rivers of Deccan, also the Jumna near its upper portion.

2. G. trilineatum[4], *Blyth*. Nepaul, Burma, and Tenasserim.

3. G. conirostre, *Steindachner*. Himalayas from affluents of the Indus and Jumna, as at Kangra and Simla.

4. G. botia, *Hamilton Buchanan*. From the Jumna after it leaves the Himalayas; common about Delhi.

5. G. telchitta, *Hamilton Buchanan*. Ganges and Jumna rivers from the Himalayas as low as Bengal and Behar.

6. G. striatum, *M'Clelland*. Khasya hills in Assam.

7. G. madraspatanum[5], *Day*. Bowany river at the foot of the Neilgherry hills.

8. G. pectinopterum[6], *M'Clelland*. Himalayan region from affluents of the Indus, Jumna, and Ganges; found from Nangra and Simla to certainly as far as Darjeeling.

9. G. cavia, *Hamilton Buchanan*. Rivers of northern Bengal.

These fishes appear to have a somewhat local distribution, 1 species being restricted to the Jumna and Deccan, one to southern Madras, 3 to the Himalayas (one of which is likewise found in Burma), 1 to the Khasyas in Assam, and 3 to the Jumna, Ganges and rivers of northern Bengal.

[1] Includes *Pimelodus nangra*, Ham. Buch.

[2] Includes:—*Pimelodus bagarius*, Ham. Buch.; *P. platespogon*, Val.; *P. carnaticus*, Jerdon; *Bagarius Buchanani*, Bleeker.

[3] Includes *G. dekkanense*, Günther.

[4] Includes *G. gracile*, Günther.

[5] I cannot detect any air-vessel in this species.

[6] *G. Stoliczkæ*, Steindachner (adult;) *G. modestum*, Day (young)

Genus EUGLYPTOSTERNUM.

1. E. LINEATUM, *Day.* Head waters of the Jumna. Upper Assam, from the neighbourhood of the Himalayas.

Genus PSEUDECHENEIS.

1. P. SULCATUS, *M'Clelland.* Darjeeling and Khasya hills.

Genus EXOSTOMA.

1. E. LABIATUM, *M'Clelland.* Mishmee Mountains in East Assam.
2. E. BLYTHII, *Day.* Darjeeling.
3. E. BERDMOREI, *Blyth.* Tenasserim.
4. E. STOLICZKÆ, *Day.* Head waters of Indus.

The foregoing 85 species of Indian freshwater Siluroid fishes are thus distributed.

Indian region[1]	1
,, to Malay archipelago	5
,, (excluding Sind) to Burma	5
,, Ceylon and Burma	1
,, (excluding Southern India and Malabar) to Burma	2
,, (excluding Southern India and Malabar) to Assam	1
,, (excluding Southern India and the Deccan) to Assam	3
,, (excluding Southern India and the Deccan) to Burma	2
,, to Cochin-China	1
Indus, Ganges, and Jumna rivers	3
Indus	1
Ganges, Jumna, and the Deccan	4
,, ,, to Burma	1
Deccan	4
Bengal	6
Bengal, Orissa, and Assam	1
,, ,, ,, to Burma	1
Bengal, and Assam to Burma	3
,, ,, ,,	1
,, and Burma	2
Himalayan region	6
,, ,, and Burma	1

[1] This includes India, Sind, and the Punjaub only.

Burma	1
" and Cochin-China	1
Assam	8
Orissa	1
Madras, Assam, and Burma	1
Base of Neilgherry hills in Madras	2
South India and Malabar	1
" " Ceylon	1
Ceylon	1
" and Java	1
West coast of India and Malay archipelago	1
" "	6
" " and Coimbatore	1

The foregoing shows that the 78 species are restricted to the Indian region (including Burma and Ceylon); 6 are distributed from the Indian region (excluding Ceylon) to the Malay archipelago, and 1 extends from Ceylon to the Malay archipelago. Consequently we find no species of Indian freshwater Siluroid extending its range to Africa, whereas 6 do to the Malay archipelago.

Of the genera, as I have already remarked, only 1 is common to India and Africa, whilst that is also found in the Malay archipelago, which possesses 10 more Indian genera.

So far, results would appear to show us that the present race of freshwater fishes of India is much more closely related to a Malayan than it is to an African fish-fauna.

Notes on the Genus *Alveolites*, Lamarck, and on some allied Forms of Palæozoic Corals. By Prof. H. ALLEYNE NICHOLSON, M.D., D.Sc., F.R.S.E., F.L.S., and ROBERT ETHERIDGE, Jun., F.G.S.

[Read May 3, 1877.]

(PLATES XIX. & XX.)

WE have recently had occasion to examine a large series of specimens of that group of corals to which the name of "*Alveolites*" is generally given, as well as of various allied forms, from the Carboniferous rocks of the north of England and south of Scotland, the Devonian rocks of Devonshire and North America, and

the Upper Silurian rocks of England, Sweden, and the United States; and we have found our progress greatly impeded by the very unsatisfactory condition in which *Alveolites* stands at present. Not only does it appear to be evident that the name *Alveolites* covers a number of forms which are not always united by relations of genuine affinity, but even those forms which may be regarded as the *types* of *Alveolites* are only separable from certain allied groups by characters difficult to define or discover, and sometimes of dubious value and uncertain interpretation. Under these circumstances, it may not be useless that we should lay before our fellow workers the results of our researches so far as they have gone at present, more by way of discussion and suggestion than of dogmatizing or of laying down positive conclusions or formulating final definitions.

The genus *Alveolites* was originally founded by Lamarck in the first edition of the 'Système des Animaux sans Vertèbres' (published in 1801), p. 375, for the reception of a single Devonian species which he described under the names of *A. suborbicularis* and *A. escharoides*, and for which the former title has been subsequently retained. The original definition is, "Polypary stony, thick, globular or hemispherical, formed of numerous concentric layers, which are superimposed one upon the other, each layer formed by the union of alveolar, subtubular, prismatic, contiguous cellules [or tubes], forming a network on the surface." In the 'Hist. Nat. des Anim. sans Vertèb.' (published in 1816), vol. ii. p. 184, the same definition is given with very slight alterations, the principal change being that the genus is now made to include incrusting forms. In the second edition of Lamarck's 'Hist. Nat. des Anim. sans Vertèbr.' (published in 1836), the portion relating to the corals was revised by Milne-Edwards, and the genus *Alveolites* is defined as follows (vol. ii. p. 285):—

"Corallum stony, sometimes incrusting, sometimes free and massive, formed of numerous layers which are concentrically superimposed upon one another, each layer composed of tubular, alveolar, prismatic cellules, which are somewhat short, and form a network on the surface." Four species of the genus were recognized by Lamarck, of which *A. suborbicularis* and *A. escharoides* have been subsequently united with one another. *A. madreporacea* is stated by Milne-Edwards to be a *Pocillopora*; and *A. incrustans* appears to be a Polyzoön. To the above four species Milne-Edwards added, in the work just quoted, four others, of which

A. tubiporacea and *A. milleporacea* appear to be referable to *Favosites*; *A. clavata* may perhaps be a *Chætetes*; and *A. infundibuliformis* was afterwards placed by Edwards and Haime in a new genus under the name of *Rœmeria*.

Without taking up time by discussing the views entertained as to the characters of the genus *Alveolites* and the different forms referable to it by Goldfuss, De Blainville, Michelin, Steininger, D'Orbigny, and other well-known palæontologists, we may pass on to consider those expressed by Milne-Edwards and Jules Haime in their great works on the fossil corals. In the Introduction to the 'Monograph of the British Fossil Corals' (Palæontographical Society, 1850, p. lx), these distinguished authorities place the genus *Alveolites* in the group of the Favositidæ proper, characterized by the presence of well-developed tabulæ, the existence of mural pores, and the rudimentary condition of the septa. They define the genus as possessing a "corallum composed of superposed strata of corallites very similar to those of *Favosites*, but much shorter, and terminated by an oblique semicircular or subtriangular calice, the edge of which projects on one side." The type species of the genus is *A. spongites*, Steininger (=*A. suborbicularis*, Lamarck). In their 'Polypiers Fossiles des Terrains Paléozoiques' (p. 254), the same authors in the succeeding year redefine *Alveolites* as follows :—"Corallum forming a convex or dendroid mass. Calices oblique, subtriangular or semicircular, presenting interiorly a longitudinal protuberance which is opposed to two other smaller protuberances. These eminences appear to represent the primary septa; and no other traces of the septal apparatus can be detected. The walls are simple, well developed, pierced with a small number of mural pores. The tabulæ are complete and horizontal." After giving a history of the genus, the authors just quoted remark that the elongated teeth or eminences above alluded to constitute the most remarkable feature of the genus *Alveolites*, and that they are to be regarded as so many primary septa, the other three which form the normal cycle of six being aborted. They further add that one of these three septal teeth is always more pronounced than the other two, and that these latter may be wholly wanting.

In the 'Histoire Naturelle des Coralliaires' (vol. iii. p. 263, 1860), Milne-Edwards makes the following remarks as to *Alveolites* :—"The most striking character of *Alveolites* is furnished by the *septal system*, which is represented by three teeth or vertical

projections—one situated on the inside face of the outer lip of the calice, the others opposite the preceding, upon the inner lip of the corallite, and sometimes rudimentary. The calices are *oblique*, subtriangular or subhemispherical. Walls simple, well developed, and pierced by a small number of pores. Tabulæ complete and horizontal.". . . . "The elongated teeth or vertical projections which we see in the interior of the visceral chambers of the corallites *form the most peculiar character of Alveolites*, and recall the three principal septa which characterize the genus *Heterocœnia* amongst the Astræidæ. . . . It is also worthy of note that one of the septal projections is more developed than the other two, and often it alone may exist.

In briefly analyzing the above, it will be obvious, in the first place, that Lamarck's definition of the genus *Alveolites* does not contain a single character which would at the present day be regarded as of generic importance at all; so that the ultimate existence of the genus will depend upon whether the type species, *A. suborbicularis*, Lam., can be shown to possess characters which separate it generically from allied forms. In the second place, the various definitions given by Milne-Edwards and Haime yield, upon collation, the following characters as essentially distinctive of the genus *Alveolites* as understood by them:—(1) The corallites are furnished with lamellar walls, and are not united by any cœnenchyma. (2) The visceral chamber is traversed by well-developed horizontal tabulæ. (3) Mural pores, comparatively large and few in number, are present. (4) The corallites are oblique, shorter than in *Favosites*, and terminated by *oblique semilunar* or *subtriangular calices*. (5) There exist in the interior of each corallite three elongated teeth, which represent the primary septa, and of which one is always larger than the others, and may be the only one present. (6) The corallites are arranged in the massive and incrusting forms in superimposed layers.

Alveolites suborbicularis, Lam., the type species, possesses all the above-mentioned characters, and is therefore, to begin with, clearly a member of the Favositidæ proper. In order, however, to establish the validity of the genus *Alveolites*, it is further necessary to prove that *A. suborbicularis* is generically separable from *Favosites*; and there are only two of the above-mentioned characters, namely the obliquity of the calices and the presence of septal teeth, which require special consideration in this connexion. Moreover, even if the generic distinctness of *A. suborbi-*

cularis and its immediate allies be satisfactorily established, there still remain various forms more or less resembling *A. suborbicularis*, which differ considerably from it in minute structure, and which must therefore be referred to different groups. In what follows we shall briefly state the results of our examination of a large number of such forms, which we may provisionally arrange in groups according to their affinities. We need only add that our observations, when practicable, have been conducted by means of transparent microscopic sections, as well as by the examination of the actual specimens themselves.

Group A. ALVEOLITES SUBORBICULARIS, *Lamarck.*

The characteristic Devonian coral known under the above name is thus described by Milne-Edwards and Haime ('Brit. Foss. Cor.' p. 219).

"*Corallum* composite, forming irregular incrustated masses which are in general fixed on ramose *Favosites* or on a *Cyathophyllum*, and are composed of superposed layers terminated by an irregular or subgibbose surface. *Calices* very oblique, closely set (but unequally so), elongated transversely, subtriangular, and turned towards the edge of the corallum. The outer or under side of these calices bears interiorly a small elongated ridge which appears to represent a septum, and is placed opposite to a small notch. Transverse diameter of the calices about $\frac{2}{5}$ of a line; small diameter about half that length."

As this is the type species of the genus, it will be advisable to somewhat minutely examine its characters as set forth in the above description, together with some others not mentioned therein, with the view of determining, if possible, which of them possess a more than merely specific value.

In the first place, one of the most conspicuous *external* characters of *Alveolites suborbicularis* is that the corallites are oblique, with the result that the calices are correspondingly oblique, one lip being shorter than the other, and the aperture being more or less elongated transversely, and subtriangular or semilunar in shape. Though this presents a superficially conspicuous feature whereby to separate *Alveolites* from *Favosites*, it is quite evident that this character is by no means one of generic value. Not only is it possessed by forms otherwise different, but it is absent in some corals which are usually placed in *Alveolites* (*e. g.* in *A. septosa*, Flem.). It has, moreover, been pointed out by Dr. Lind-

ström ('Ann. Nat. Hist.' ser. 4, vol. xviii. p. 12) that the well-known coral described by Milne-Edwards and Haime under the name of *A. Fougtii* is in reality only provided with oblique corallites when young, and that in its adult state the tubes lose much of their previous inclination, and the calices become simply irregular in form. As *A. Fougtii* shows, in addition, the numerous regularly arranged mural pores and the obscure septal striæ of *Favosites*, Lindström has removed it from *Alveolites* to the latter genus; and the specimens which the Swedish palæontologist has kindly supplied to us would appear to fully warrant this step.

In the second place, *A. suborbicularis* has the walls of the corallites perforated by mural pores, which are admirably displayed in polished sections. The pores are of large size, placed at irregular but moderate intervals (from $\frac{1}{3}$ to $\frac{1}{2}$ a line or more) apart, and arranged in *single* rows on the sides of the tubes. Though the mural pores are few, irregular, and comparatively of large size, and thus differ from the numerous, regularly placed pores of *Favosites*, it is quite clear that this feature cannot possibly be made one of generic value. Indeed, though excellently seen in the present species, many of the forms with small tubes can hardly be proved to possess these openings at all, save by some chance specimen in some special state of preservation. The presence or absence of mural pores is thus a feature upon which great classificatory value cannot be set in practice, though theoretically the point is one of high value and deserving of all attention. In many instances, however, even where the specimens are excellently preserved, it is impossible to determine whether mural pores exist or not; and this is particularly the case in *Alveolites*, where the tubes are comparatively minute and the mural pores few and scattered. In these cases one has hardly any thing to rely upon except the *chance* that a transparent longitudinal section may lay bare the wall of one of the tubes, and may thus bring to light the mural pores. Very often, however, longitudinal slices fail to reveal any pores, even in forms which are with certainty known to possess them; so that the mere fact of their apparent absence can only be allowed to count for very little. Moreover we have found that numerous specimens of *Favosites*, in all other respects in a state of the most admirable preservation, fail to exhibit the smallest traces of mural pores, though these openings are both numerous and close-set in this genus. It is therefore clear that the visibility of the mural pores depends greatly upon the condition of

fossilization, though it is very difficult to say why some specimens should show them conspicuously whilst others, apparently in an absolutely identical state of preservation and taken from the same bed, show no traces of them.

In the third place *A. suborbicularis* possesses numerous complete tabulæ; but these structures present nothing to distinguish them from the tabulæ of *Favosites*.

Fourthly, the corallites of *A. suborbicularis* are short, and are superimposed on one another in successive concentric layers. These characters, though sufficient to superficially distinguish specimens from examples of the more typical forms of *Favosites*, are obviously of nothing more than specific value. Similar features are found in some species of *Favosites*, while such forms of *Alveolites* as *A. septosa*, Flem., have comparatively long corallites.

Lastly, *A. suborbicularis* exhibits the curious feature that there occurs on the outer lip of the calices a single elongated ridge, which is believed to represent a single primary septum. Our specimens of this species, being wholly polished slices from the Devonian of Devonshire, fail to show this character; but it has been fully described by Milne-Edwards and Haime, and it is excellently figured by Goldfuss (Petref. Germ. Taf. xxviii. fig. 1, *h*). That this tooth-like ridge is, in the case of *this* species, truly a rudimentary septum seems highly probable. It is apparently constant in position, and in its development, and it appears to be present in all the calices in well-preserved specimens. What may be its classificatory value we shall discuss immediately, merely stating now that it is evidently quite different in its nature from the so-called "septal teeth" of such corals as *A. septosa*, Flem., and *A. depressa*, Flem.

A. Labechei, Edw. & H., is in many respects closely allied to *A. suborbicularis*, Lam.; but Milne-Edwards and Haime state that it has a septal ridge resembling that of the latter species, but only "slightly developed," or "very indistinct." *A. Grayi*, Edw. & H., is also closely related to the preceding, the septal ridge in the interior of each corallite being "in general distinct, but not very prominent." We have not been able to examine this last-named species fully; but we have not succeeded in detecting the septal ridge in such examples of *A. Labechei* as have come under our notice (from the Upper Silurian of Dudley and of Sweden).

A. compressa, E. & H., is another massive form allied to *A. suborbicularis*. It is stated by Milne-Edwards and Haime to possess three septal teeth, which do not differ in size. So far as our ob-

servations go, the calices certainly do exhibit tooth-like processes extending into the interior of the visceral chamber; but we have not been able to make out that the number of these is constant, nor are we satisfied that they are identical in their nature with the septal ridge of *A. suborbicularis*.

A. Battersbyi, Edw. & H., unquestionably possesses spiniform septa, several of these being placed in general round the circumference of a single calice. Not only are these septal spines more numerous than the ridges or teeth of *A. suborbicularis* or *A. compressa*, but *A. Battersbyi* seems in all essential respects to be a genuine *Favosites*, various species of the latter genus having distinct though rudimentary septa.

Various other forms of *Alveolites* have been stated to possess from one to three septal teeth (such as *A. denticulata*, Edw. & H., *A. repens*, Fougt, and *A. cryptodens*, Billings); but we are not sufficiently acquainted with these to pronounce any opinion as to their structure. *A. septosa*, Flem., and *A. depressa*, Flem., are also provided with structures which have been generally regarded as septal teeth; but we shall discuss the nature of these subsequently.

In the meanwhile it is evident that the question as to the validity of the genus *Alveolites* will turn wholly upon the view which may be taken as to the structure of *A. suborbicularis*, Lam., the original type of the genus; and it seems tolerably certain that with this we may place *A. compressa*, E. & H., *A. Labechei*, E. & H., and *A. Grayi*, E. & H., at any rate provisionally. We have seen that the genus *Alveolites*, as thus typified, agrees with *Favosites* in the possession of corallites with lamellar walls not united by a cœnenchyma, in the existence of mural pores, and in the possession of complete and well-developed tabulæ. We have further seen that the obliquity of the calices, the shortness of the corallites, the size and number of the mural pores, and the fact that the corallum is composed of superimposed layers cannot be regarded as points of more than specific value. There remains, then, only to consider whether the presence of from one to three septal ridges (accepting this interpretation of their nature) in the forms just mentioned can be regarded as sufficient to separate them generically from *Favosites*. We have satisfied ourselves that no other character can be brought forward which is sufficiently important to elevate *Alveolites* to the rank of a genus distinct from *Favosites*; and this view seems in the main to be precisely that held by Milne-Edwards and Haime. With our present knowledge it seems unwise to abandon the genus *Alveolites* altogether; but it is at the same

time perhaps improbable that future investigations will justify its permanent retention. Rudimentary septa are by no means unknown in *Favosites*, though not so regularly disposed or so striking by their isolation as in *A. suborbicularis*; and genera founded upon *single* characters may be at any moment overthrown by the discovery of intermediate forms.

Group B. Cœnites, Eichwald.

With regard to the genus *Cœnites*, Eichw., we wish merely to suggest the possibility that it may ultimately have to be suppressed if the genus *Alveolites* be retained for *A. suborbicularis* and its immediate allies. The genus was originally founded by Eichwald in 1829 (Zool. Spec. i. p. 197), and was defined by him in the 'Lethæa Rossica' (vol. i. p. 457) as comprising dendroid or lamellar and incrusting corals, with semicircular or triangular calices, provided with a single rudimentary septal ridge on their lower lips, the corallites being united by an abundant cœnenchyma. In all the above-mentioned characters, except the alleged presence of a cœnenchyma, the genus cannot be separated from *Alveolites* as represented by *A. suborbicularis*. The presence of a cœnenchyma would doubtless be sufficient ground for generic distinction; but the few observations we have been able to make on this point lead us to doubt if a true cœnenchyma exists at all in *Cœnites*. More especially, we have examined specimens of *C. orientalis*, Eichwald (supplied to us from the Upper Silurian of Gotland through the kindness of Dr. Lindström), by means of thin sections prepared for the microscope; and in this form we find the apparent cœnenchyma to be due to a secondary thickening of the walls of the corallites, more particularly in the neighbourhood of their mouths, the external boundaries of the tubes remaining quite distinct.

Group C. Pachypora, *Lindström*.

In 1873 Lindström ("Några Anteckningar om *Anthozoa Tabulata*," Öfversigt af. K. Vetensk.-Akad. Förhandl.) gave the name of *Pachypora* to a new genus of corals, to which he assigned the following characters:—"Calices annular, at the extremities of the branches obliquely semilunar, with sparse spiniform septa. The calices surrounded by dense, delicate, concentric laminæ, so as to be superficially remote. Walls perforated with canals." The only species described is *P. lamellicornis*, which is stated to possess flattened branches, often coalescent and forming broad laminæ, the tabulæ being extremely few or inconspicuous.

Dr. Lindström has kindly furnished us with specimens of *P.*

lamellicornis from the Upper Silurian of Wisby; and after a careful microscopic examination of its characters, we are enabled to entirely confirm his description. We have also fully examined two corals from the Devonian of North America, which were originally referred to *Alveolites*, but which we find to be essentially identical with *Pachypora*, and therefore to be properly referable to this genus. The corals in question are *Alveolites Fischeri*, Billings, and *A. frondosa*, Nich.

A. Fischeri, Bill., agrees in all important points with *Pachypora lamellicornis*, Lindström, though specifically distinct. It forms flattened expansions or fronds, rarely incrusting foreign bodies, from one to four lines in thickness, and often of considerable size. The corallites are disposed obliquely to the surfaces, diverging in opposite directions from a central plane, and opening by distinct calices on both aspects of the frond. The walls of the corallites are thickened as they approach the surface, and are formed of numerous delicate concentric laminæ where they surround the calices. The calices are oval or rounded, often semilunar, remote, and neither exhibiting a single septal tooth nor rudimentary spiniform septa. The walls of the corallites are perforated with a few remote mural pores of large size; and the tabulæ are either absent or are few and remote.

In all the above characters *A. Fischeri* agrees with *Pachypora lamellicornis*, save in wanting the comparatively numerous rudimentary septa which can be observed in well-preserved examples of the latter. We have no hesitation, therefore in referring the two to the same generic group; and *A. Fischeri* must in future stand as *Pachypora Fischeri*.

Alveolites frondosa, Nich., also from the Devonian of North America, agrees in all the essential features of its organization with the preceding, and must therefore be removed to the genus *Pachypora*. It differs from *P. Fischeri*, however, in the comparatively small size of the corallites, and the fact that the calices are distinctly semilunar or subtriangular, often curved and fissure-like. In well-preserved examples also there are indications of the existence of two small tooth-like inward projections of the lower lip of the calice, thus establishing a passage between *Pachypora* and the forms generally referred to *Cœnites*, Eichw. The mural pores appear to be few and remote; and we have been unable to detect tabulæ in longitudinal sections of this species.

Group D. Alveolites septosa, *Fleming*.

Our specimens of this species form hemispherical or pyriform

masses, sometimes of great size (reaching occasionally a foot and a half in diameter and five or six inches in height), and have been derived from the Carboniferous Limestone series of Scotland. The composition of these masses varies in different cases. In some examples from Ecclefechan the corallum is composed of numerous concentric layers, each layer being of comparatively small thickness. In other examples, as in some huge masses from the Carboniferous Limestone series of Dunbar, the corallites are long and basaltiform, extending the whole height of the corallum. In both cases the corallites may fairly be said to be *erect*, in the same sense that this term is applied to the position of the corallites in a similarly shaped mass of *Favosites* or *Chætetes*; that is to say, the corallites in a hemispherical corallum are vertical in the centre of the mass, and curve gently outwards as the margins are approached, thus having their terminal portions always directed at right angles to the surface upon which they open. Hence the *calices* entirely want the obliquity which is so characteristic of *Alveolites suborbicularis* and its allies. A reference to the figures of *A. septosa* given by Milne-Edwards and Haime in the Monograph of the British Corals (pl. xlv. fig. 5 *b*) will at once show that the calices of this species, instead of being like those of *Alveolites suborbicularis*, entirely resemble in this respect the calices of any massive *Favosites* or *Chætetes*.

The calices in our specimens of *A. septosa* are from three to four in a line, generally the former, their shape being somewhat irregular, but on the whole five- or six-sided, or at any rate more or less prismatic. In places the calices become transversely elongated; but they never assume the characteristic semilunar or subtriangular appearance of those of *A. suborbicularis* and its congeners. The walls of the corallites are thin; and the margins of the calices, as noticed by M'Coy ('Brit. Foss.' p. 82), are sometimes tuberculated or coarsely granulated.

After a careful examination of well-preserved specimens, both on fractured surfaces and in polished sections, we have entirely failed to detect any mural pores. For reasons previously stated, we do not regard the apparent absence of pores in our specimens as absolutely conclusive as to their non-existence, though we are inclined to believe that the walls of the corallites are really imperforate.

The corallites of our examples of *A. septosa* are crossed by well-developed complete horizontal tabulæ, generally dispersed with

great regularity; but the most remarkable feature is the presence in many of the corallites of a longitudinal or vertical ridge, partially dividing the visceral chamber into two portions. Sometimes this ridge is barely perceptible, or even wholly absent; at other times it extends halfway across the visceral cavity; and sometimes it nearly touches the opposite wall. In some parts of a large corallum almost every corallite may possess one of these ridges, whilst in other parts not a single structure of the kind is to be detected. Nor is there always but one of these ridges within the cavity of a single corallite, but there may be two or three, in which case one is generally much larger than the others. The significance and nature of these vertical ridges will be considered immediately; but it is in the meanwhile necessary to briefly glance at two corals which are very closely allied to *A. septosa*, and which undoubtedly belong to the same group.

One of the corals in question has been found by us in considerable abundance in the Carboniferous Limestone of the north of England. It occurs in the form of hemispherical, subglobose, or irregular masses, with a convex surface, often of considerable size, composed of prismatic corallites, which may or may not be arranged in successive superimposed layers half an inch or more in thickness. In other instances, the corallites are tall and basaltiform; but in either case they are "erect," in the sense in which this term has been previously used. The calices, therefore, are not *oblique*, but are like those of *A. septosa*. There are generally about five calices in one line; and though irregular in shape and size, they are essentially subhexagonal in shape. The walls of the corallites are thick; but we have wholly failed to discover any mural pores. In transverse sections, certain of the corallites show a strong tooth-like process on one side, sometimes opposed to two smaller teeth; and these ridges may be short, or they may extend halfway or more across the visceral chamber, whilst they are wanting altogether in a large number of the corallites. In longitudinal sections the corallites are seen to be crossed by remote horizontal tabulæ, which are not uncommonly placed at the same level in contiguous tubes, and which may be wanting altogether in certain layers.

The corals we have just described present a very close resemblance to *A. septosa*, Flem., from which they can only be distinguished by the smaller size of the corallites, the somewhat thicker walls of the tubes, and the slightly more remote tabulæ. Whether

they may not be simply a variety of *A. septosa* we are not prepared to say; but we think little doubt can be entertained as to their substantial identity with the *Chætetes radians* of Fischer, a coral originally described from Russian specimens ('Oryct. de Moscou,' p. 160, pl. 33. fig. 3), but which is also quoted by Milne-Edwards and Haime from the Carboniferous Limestone of Kendal—on precisely the same horizon as some of our own specimens. We have unfortunately been unable to examine any authentic Russian examples of *Chætetes radians*; but our specimens agree so perfectly and in such minute particulars with those described and figured by Lonsdale ('Russ. and Ural,' Appendix, vol. i. p. 595, pl. A. fig. 9), that we are unable to hesitate as to their identity.

Lastly, in *Alveolites depressa*, Flem., we have a third coral which is obviously referable to the same group as the preceding two forms. The specimens which we possess of this species are large massive examples, agreeing in all essential points with the description given by Milne-Edwards and Haime, except that we cannot say that we have satisfactorily determined the presence of vertical ridges in the interior of any of the corallites. These, however, are both described and figured by the authors just mentioned. The species differs almost solely in the minute size of its tubes from the two preceding, the corallites being from eight to ten in the space of a line. The corallites are erect; the calices are subhexagonal and not oblique; the tabulæ are complete, remote, singularly regular, and often placed on the same level; no mural pores can be detected; and a rough fracture (as in the case of the two previously mentioned forms) exposes the interior of the corallites.

We have, then, arrived at the conviction that *Alveolites septosa*, Flem., *Chætetes radians*, Fischer, and *Alveolites depressa*, Flem., form a very natural group of corals, which chiefly differ from one another in the very trivial character that the corallites are of different dimensions. It still remains, however, for consideration to what generic group these forms can be properly referred; and on this question we have the following observations to make, the only points requiring special discussion being the presence or absence of mural pores, the nature of the so-called "septal tooth," and the relations of the corallites to one another.

As regards the first of these points, our specimens have only yielded the negative result that we have been unable to detect any signs of mural pores. In this particular instance, however, we

are perhaps warranted in attaching great weight to this negative evidence, seeing that we have examined a large series of specimens from different localities, and from different beds, in different states of preservation, and by means of polished sections and thin transparent slices as well as by broken surfaces. We are disposed, then, to believe that mural pores are really wanting in *A. septosa*, Flem., *A. depressa*, Flem., and *Chœtetes radians*, Fischer; and we may add that Milne-Edwards and Haime expressly affirm the absence of pores in the latter. If this view be correct, it is clear that the two first-mentioned of these forms can no longer be retained in *Alveolites*, from which they further differ in their comparatively erect corallites and their *non-oblique* calices.

As regards the second point, namely the nature of the so-called "septal tooth," this process is very conspicuous in *A. septosa* and in *Chœtetes radians*, and can be most readily examined by means of thin sections cut at right angles to the course of the tubes. In *A. depressa* the same processes exist, though not so conspicuous; and we entertain no doubt as to their being of precisely the same nature in all these forms. By Milne-Edwards and Haime this tooth in *A. septosa* and *A. depressa* was regarded as representing a single primary septum; and they compared it with the elongated septal ridge of *A. suborbicularis*—an analogy which is increased by the fact that the process has sometimes one or two smaller teeth opposed to it, as in *A. denticulata*, E. & H. Against this view, however, it must be urged that the tooth-like process of *A. septosa* and *A. depressa* is by no means universal in its occurrence, nor constant in its development. It is only present occasionally, in certain of the calices, and is often absent over considerable areas, whilst it varies in size from a hardly perceptible protuberance up to a vertical lamina extending halfway or more across the visceral chamber. These facts militate strongly against the comparison of these processes to the septal ridges of *A. suborbicularis*; whilst several of our specimens of *A. septosa* show in addition numerous obscure longitudinal striæ, which we believe to be the true representatives of the septa. On the other hand, Lonsdale regarded the tooth-like processes of *Chœtetes radians*, Fischer, as being of the nature of inflections of the walls of the corallite preliminary to its fission into two tubes. This view is supported by the easily observed fact that the mode of increase in *C. radians*, as well as in *A. septosa* and *A. depressa*, is clearly by fissiparity; and it is further supported by the very variable length of the

process in different tubes, by its often extending half way, or almost quite, across the visceral chamber, and by its absence in all but a comparatively small number of corallites, and those the largest ones. Upon the whole, therefore, we are inclined to believe that the tooth-like processes of *A. septosa*, *A. depressa*, and *Chætetes radians* are not of a septal nature at all, but that they owe their existence to fission taking place in the older corallites.

In the third place, all the three corals in question exhibit the peculiarity that the walls of the corallites are firmly amalgamated in contiguous tubes, so that a fracture does not expose the *walls* of the tubes, but lays open the cavities of the visceral chambers. Mr. Lonsdale probably attached too great a value to this character in regarding it as one of the leading peculiarities of *Chætetes* as a genus; but there can be no doubt that it is a feature of importance.

Upon reviewing all the above evidence, it seems to us to be clear that *A. depressa*, Flem., and *A. septosa* *, Flem., can no longer be retained in the genus *Alveolites* as typified by *A. suborbicularis* and its allies. On the other hand, if more extensive investigations confirm, as we believe they will, the absence of mural pores, these species must be placed in the genus *Chætetes*, side by side with *C. radians*, Fischer, and they will stand as *C. depressus*, Flem., and *C. septosus*, Flem.

Group E. CHÆTETES, *Fischer*.

The groups known as *Chætetes*, Fischer, *Monticulipora*, D'Orb., and *Stenopora*, Lonsd., differ from *Favosites* and *Alveolites* mainly in the imperforate condition of the walls of the corallites; and this undoubtedly constitutes a character of great structural importance. Owing, however, to the very small size of the tubes of many species of these groups, the absence of mural pores is often a matter more of inference than of actual observation. Without, however, entering at the present moment further into the structure and affinities of these groups, we wish to describe a species of *Chætetes* from the Carboniferous rocks of Scotland, which is in many respects allied to the forms we have just been considering:—

Chætetes hyperboreus, Nich. & Eth.

Corallum forming thin, flattened, or undulating expansions, from one to five lines in thickness, not composed of superposed layers, and often half a foot or more in diameter. The corallum is not

* It should be noted that this species was long ago described by M'Coy under the name *Chætetes septosus* (Pal. Foss. p. 82).

incrusting, but is attached to foreign bodies at one point; and the rest of the lower surface is covered with a strong wrinkled epitheca. Corallites erect, from an eighth to a tenth of a line in diameter. Calices opening upon the upper surface of the corallum, irregular in shape and size, but upon the whole more or less hexagonal, with thin walls, and wholly devoid of any trace of a septal apparatus or of septal teeth. Mural pores apparently absent. Tabulæ numerous, complete.

Most of our specimens of this form present the appearance believed by Mr. Lonsdale to be characteristic of *Chætetes*—that a rough fracture lays open the cavities of the corallites without exposing their walls. In some cases, however, the fractured surface shows the walls of the tubes; and in these, as well as in longitudinal sections, we have failed to detect any traces of mural pores. We were at first sight disposed to regard the present species as a variety of *C.* (*Alveolites*) *depressus*, Flem., with which it agrees in the size of the tubes. It is, however, sufficiently distinguished by its constantly different *form* and mode of growth, as well as by the fact, conclusively shown by thin transverse sections, that there are no traces whatever of ridges or teeth-like processes within the corallites. On the surface, the calices show a certain irregularity in form and size, which is not characteristic of the typical forms of *Chætetes*, whilst they are often transversely elongated, as in *C. septosus* and *C. depressus*. Horizontal sections, however, taken a little below the surface, prove that the corallites are essentially hexagonal in form.

Formation and Locality.—Carboniferous Limestone series, Charleston, Fife (abundant); Bathgate; Ecclefechan (Calciferous Sandstone).

Group F. Alveolites Goldfussi, *Billings.*

There still remain a number of forms which have been referred to *Alveolites*, and the true affinities of which are still doubtful. Many of these forms we have had no opportunity of sufficiently examining; and we merely wish to draw attention now to one or two corals which offer some troublesome difficulties. If we take *A. suborbicularis*, Lam., as the type of the genus *Alveolites*, we have already seen that the only essential point by which it can be separated from *Favosites* is the presence of a vertical septal ridge—three of these ridges existing in other allied forms. We have, however, some corals (such as *Alveolites Goldfussi*, Bill., and *A.*

Rœmeri, Bill., from the Devonian) which agree entirely with *Alveolites*, as generally understood, both in form and in the possession of a few irregular mural pores, but which differ from *A. suborbicularis* and its allies in possessing no traces whatever of septal ridges. In most characters these forms agree entirely with *A. Fougti*, E. & H., which has already been removed by Lindström to the genus *Favosites*. This would perhaps be the best course to pursue, provisionally at any rate, with forms such as *A. Goldfussi*, Bill.; but this would necessitate a further enlargement of the characters assigned to *Favosites*, since the corals in question differ both from the typical *Favosites* and from the aberrant *F.* (*Alveolites*) *Fougti*, in possessing few and remote mural pores. Further investigation will therefore be required before a final conclusion on this point can be arrived at.

DESCRIPTION OF PLATES XIX. & XX.

Fig. 1. A vertical section of the polished surface of a portion of *Chætetes* (*Alveolites*) *septosus*, Flem., from the "Vaults" Limestone, Lower Carboniferous group, Dunbar. Drawn from a specimen in the collection of the Geological Survey of Scotland (Edinburgh). Of natural size.

2. A portion of a horizontal section of the same specimen. At *a* is shown a portion of the matrix in which it was imbedded. Also of nat. size.

3. A small portion of the surface of fig. 2, considerably enlarged, showing the transverse sections of the corallites.

4. Applies to an outline of a flask-shaped specimen of the preceding coral, *Chætetes* (*Alveolites*) *septosus*, Flem. This was obtained from the Lower Carboniferous or Calciferous Sandstone series, Blackwood Ridge, New Quarry, Ecclefechan, Dumfriesshire. From the collection of the Geological Survey of Scotland (Edinb.). Outline reduced less than ½ nat. size.

5. The appearance of th weathered surface of the preceding, of nat. size.

6. Part of the same area as fig. 5, but considerably enlarged.

7. A partially longitudinal and somewhat obliquely fractured section of *Chætetes ? radians*, Fischer. From the Carboniferous Limestone, Hardendale, Nab, Shap, Westmoreland. Of nat. size, from a specimen in the cabinet of Prof. Nicholson.

8. A small portion of the weathered surface of the preceding specimen.

9. A horizontal section of the preceding as viewed under the microscope, and magnified about 6 diameters.

10. A vertical section of the same, also enlarged 6 diameters.

11. A portion of the exposed and slightly weathered surface of a mass of *Chætetes hyperboreus*, Nicholson and Etheridge. From the Lower Carboniferous Limestone group, Charleston, Fife. Drawn of nat. size from a specimen in the cabinet of Prof. Nicholson.

12. Exhibits a vertical view of part of the edge of the above slab of *Chætetes hyperboreus*, showing the comparative tenuity of the expansion. About nat. size.
13. A transparent vertical section of *Chætetes hyperboreus*, magnified 7 diameters.
14. A horizontal section of the same coral, × 7 diam.
15. The surface, slightly weathered, of a piece of *Pachypora lamellicornis*, Lindström. From the Wenlock (Upper Silurian), Gotland. Drawn of nat. size from a specimen in the cabinet of Prof. Nicholson.
16. A section in the plane of the frond of part of the same specimen of *P. lamellicornis*, rubbed down and viewed by transmitted light, × 4 diam. Owing to the undulations of the specimen, the section cuts across the corallites obliquely.
17. A section at right angles to the plane of the frond of the same, magnified 4 diam.
18. A superficial view of the surface of a fragment of *Pachypora* (*Alveolites*) *Fischeri*, Billings. From the Hamilton group, Middle Devonian, Arkona, Ontario. Encrinital joints are adherent to the surface of the specimen. Of nat. size and sketched from a specimen in Prof. Nicholson's cabinet.
19. A microscopical vertical section of fig. 18, × 7 diam.
20. A segment of a transparent horizontal section of the same, also magnified 7 diameters.
21. *Pachypora* (*Alveolites*) *frondosa*, Nicholson. Vertical transparent section, × 6 diam. Specimen obtained from the Hamilton group, Middle Devonian, Arkona, Ontario, and now in Prof, Nicholson's cabinet.
22. A vertical section of the same specimen of *P. frondosa*, also × 6 diameters.

On the Sacral Plexus and Sacral Vertebræ of Lizards. By St. George Mivart, Sec. L.S., and the Rev. Robert Clarke, F.L.S.

[Read May 3, 1877.]

(Abstract.)

The authors mention that of late it has been recognized that, in any attempt to answer the question as to which vertebra of any lower animal answers to the first sacral vertebra of Man, the nervous no less than the osteological relations of the parts should be carefully investigated. And it has been considered that the nervous rather than the osteological relations should be deemed the more important: in fact it has been sometimes asserted that the nerves must be taken as the fixed points, and that the bones must rather have their homology decided by the nerves, than *vice versâ*.

Should it be possible to show that in any group of reptiles, both

the nervous and osteological relations of any vertebra constantly agree with the nervous and osteological relation of Man's first sacral vertebra, the homology between such two parts may well be taken as thereby established; but if either of these sets of relations exhibit discrepancy, then of course such homology cannot be considered satisfactorily determined.

Nor can we justly set aside osteological in favour of nervous resemblances if it should turn out that the nerves themselves exhibit notable variations of conditions as we pass from one allied form to another—*a fortiori* if there should be variations in this respect even within the limits of a species. It might surely be anticipated that more or less variation would be found to exist innervous as well as in skeletal structures; and in the event of such anticipations being justified, the determination of sacral homology must depend upon a comparison of the values of the conflicting claims of different degrees of resemblance in both the osseous and nervous systems—unless we prefer to consider the osteological sacrum and the nervous sacrum as two distinct structures, which may or may not completely coincide, and may or may not widely diverge.

The authors afterwards discuss the opinions held by Professor Gegenbaur with regard to the pelvic relations in birds and some reptiles, also those of Professor Hoffmann concerning the lumbar and sacral plexuses of Batrachians and Reptiles.

Then follows an account of dissections of the Chameleon (*Chamæleo vulgaris*), the Green Lizard (*Lacerta viridis*), the common Teguexin (*Teius teguexin*), the Bearded Lizard (*Grammatophora barbata*), the *Agama colonorum*, the Tuberculated Lizard (*Iguana tuberculata*), and of the Monitor (*M. arenaria*).

On these dissections are based some remarks on the general condition of the nervous and osseous structures of the sacral region in Lizards, according to their views and as compared with those held by Gegenbaur and Hoffmann. To this succeed other chapters devoted to a consideration of the sacral region of Batrachians, to the sacral region of Mammals, and to the sacral region of Birds, each discussed in a similar spirit.

Their generalizations to the foregoing may be thus summarized:—

It appears, then, that in Lizards generally, the lumbar plexus may be formed by from two to three roots, and that the most preaxial of these is here in advance of the fourth presacral nerve, while the most postaxial root is never more postaxial than the first

presacral nerve. But *Monitor* and *Chamæleo* present a slight exception in certain respects.

In all the Reptilia examined and enumerated by the authors, the transverse processes which abut against the ilium are wholly or in part parapophysial, and are in serial relation (serial homologues) with the capitular processes (or the capitular parts of the transverse processes) of the more preaxial vertebræ. The junction of the sacral vertebræ with the ilium is much postacetabular in Saurians; but in Crocodilia and Tortoises (some at least) it is about opposite the acetabulum.

In Batrachians the transverse processes abutting against the ilium are parapophysial, but diapophysial in nature like those of Reptiles.

In Mammals as compared with Lizards, it would seem, with respect to nerves, that the first and second sacral vertebræ (say, for instance, of the Cat), answer very well to the two vertebræ with enlarged transverse processes of Lizards, while osteologically they of course also answer very well to them. There can be little doubt, however, that the first two sacral vertebræ of the Cat are to be considered homologous with the anterior human sacral vertebræ; and therefore it would seem that the two ilium-joining vertebræ of Lizards should be considered homologous with the anterior human sacral vertebræ.

In Man, the Cat, and also in other Mammals down to the Echidna, the transverse processes abutting against the ilium are parapophysial, like those of Reptiles and Batrachians. In all the Mammals examined by the authors, however, the junction of the sacral transverse processes with the ilia is preacetabular, although that junction is much less preacetabular in position in Man than it is in most Mammals.

Altogether, from the osseous and nervous conditions evinced together in the groups hitherto referred to, the authors propose the following definition of a "Sacral Vertebra" in Mammals, Reptiles, and Batrachians:—"*vertebra with parapophysial transverse processes which abut against the ilium, preaxial or postaxial or opposite to the acetabulum, and having a root of the sciatic plexus coming forth either immediately preaxiad or postaxiad of it.*"

This definition will exclude from the sacrum, as not abutting against the ilium, of Man, the more posterior vertebræ called "sacral" in anthropotomy. But in the lower mammals (even already in Apes) the number of so-called "sacral" vertebræ aug-

ments more or less with age by the ankylosis of the sacral vertebræ, so as not to render the extent of the "sacrum" very variable. It would surely be well, then, to distinguish the human sacral vertebræ, like the ribs, into true and false, those being the true sacral vertebræ which abut against the ilium.

In Birds the determination of the homological relations of the different parts of the postdorsal part of the spinal column is a matter of much difficulty. On the whole, and seeing on the one hand the manifest homology between the sacral vertebræ of Man and Lizards by the help of Crocodiles and Tortoises, and on the other hand the manifest homology between the sacral vertebræ of Lizards and the posterior parapophysial vertebræ of most Birds, the authors think it better to regard the latter vertebræ in Birds as alone truly sacral, and to regard such forms as *Buceros*, *Pica*, and certain Parrots as differing from the rule of the Class in the suppression of their parapophysial processes, and *Fregatta* as differing from the same rule by the development of parapophyses in all the vertebræ of this region.

The sacral vertebræ in Birds may be defined, then, as "*vertebræ having one of the more postaxial roots of the sciatic plexus coming forth either immediately preaxiad or postaxiad, and having parapophysial transverse processes abutting against the ilium, such vertebræ being placed immediately postaxiad to vertebræ which are devoid of such parapophyses, or else being the homologues of a vertebra so conditioned in most birds.*

By the combination of these two definitions, as given above (the one for Mammals, Reptiles, and Batrachians, and the other for Birds), it seems to the authors that the sacral vertebræ may be defined in all Vertebrata above Fishes which have pelvic limbs.

On the Nymph-stage of the *Embidæ*, with notes on the Habits of the Family, &c. By R. M'Lachlan, Esq., F.R.S., F.L.S., &c.

[Read June 7, 1877.]

(Plate XXI.)

Introductory Remarks.

In the year 1837 Prof. Westwood published in the 'Transactions' of this Society (vol. xvii. pp. 369–375, pl. xi.) a memoir entitled "Characters of *Embia*, a Genus of Insects allied to the White Ants; with descriptions of the species of which it is composed," wherein he gave a résumé of the little hitherto known concerning

these singular insects, and subdivided the genus *Embia* (instituted by Latreille in 1825) into three, viz. *Embia*, *Oligotoma*, and *Olyntha*, each containing a single species, all that were known at that time. Forty years have elapsed since the publication of that paper; yet even at the present time the number of known species is very small. In 1837, only the larval (or absolutely wingless) form, and the fully developed insect had been observed; there remained a gap to be filled up. The analogy of the group with the *Termites* made it evident that the metamorphoses (or, rather, the partial absence of metamorphoses) were the same in both; yet the penultimate stage, in which the creatures should have abbreviated wings, remained to be discovered this has only just been done, and under very singular circumstances.

Quite at the end of last year Mr. W. H. Michael, of Highgate, an extensive grower of exotic orchids, discovered that a large mass of *Saccolobium retusum*, purchased from a London nurseryman, was apparently being damaged by some insect; and examination revealed the presence of numerous Embidæ on the roots concealed in silken tunnels. He visited the nursery whence they were obtained, and found there more examples, including a winged insect which was unfortunately lost. In the 'Gardener's Chronicle,' for Dec. 30, 1876, Mr. Michael gave an account of the discovery, illustrated by magnified figures (of which I shall presently have more to say), and accompanied by notes by Prof. Westwood in which a doubt was implied as to the damage to the orchids being occasioned by the Embidæ. In a subsequent number of the same periodical I gave a few notes in which I stated that Prof. Westwood's doubt appeared to be well founded. However, the sequel proved, tolerably to my satisfaction, that the insects had eaten the roots to some extent; but I still think that some old wounds on the plants, attributed by Mr. Michael's gardener to them, had resulted from other causes. About the same time I received from a mutual friend (Mr. W. A. Forbes) a well-grown larva, but showing no traces whatever of rudimentary wings. But the figure puzzled me much. It showed what apappeared to be short rudimentary metathoracic wings, but no trace of the mesothoracic pair. I am of opinion that this pair had been accidentally destroyed, and that the figure give the first indication of the "nymph" stage in the group. On th 24th of January of this year I received a note from Mr. Michael's son with the information that "we have just discovered three *Embia*

nymphs," and inviting me to examine them. This I almost immediately did; but there were then only two, one having escaped. Of these, one was kindly presented to me; but it soon died (after having considerably decreased in size) owing to my inability to furnish it with the moist warm atmosphere no doubt necessary; the other was retained in the hothouse, and subsequently developed into a perfect insect, an undescribed species of *Oligotoma*.

The nymph that died with me I placed in alcohol. It is now only 9 millimètres long, but was at least one third longer when I first had it. The rudimentary wings are elongate-oval in form, and show evident traces of neuration. The mesothoracic pair extend to the posterior margin of the second abdominal segment. The general characters are but slightly modified; but the legs (especially the anterior) more resemble those of the perfect insect than those of the wingless larval condition, and the eyes are considerably larger than in the latter. The antennæ (in this species) appear to be 24-jointed in all the stages (but young larvæ have not been examined); but the joints are more elongate in the perfect insect, and those at the base undergo considerable changes in length from the larval to the mature condition.

Habits &c. of the Embidæ.

Probably the first notice (at any rate the first of any importance) appeared in the great French work on the "Exploration scientifique de l'Algérie, Histoire naturelle des Animaux articulés, Insectes," pp. 113–114 (1849), from the pen of M. Lucas, who says he found *Embia mauritanica* "vivant en famille dans les lieux sablonneux, et se tenant sur les tiges des grandes herbes; j'en rencontrai une douzaine d'individus, qui parcouraient de haut en bas une tige desséchée de *Scilla maritima*; elle est très-agile, et se laisse saisir sans se servir de ses ailes pour prendre la fuite." . . . . . "La larve que j'ai trouvée dans les environs d'Alger, se tient sous les pierres humides, et habite de petits fourreaux de soie, dans lesquels elle se retire lorsqu'on cherche à s'emparer d'elle. Elle est très-agile, carnassière, et n'est pas très-rare pendant la saison d'hiver. Ayant été obligé de partir pour Constantine dans les premiers jours de Mars, je n'ai pu suivre d'une manière bien detaillée les transformations de cette larve, et, à ce sujet, voici ce que j'ai remarqué: avant de quitter la province d'Alger, j'avais enfermé séparément, dans plusieurs boîtes,

quelques-unes de ces larves avec des insectes, afin qu'elles pussent se nourrir. À mon retour de la province de Constantine en Octobre, où je fis un séjour de huit mois, j'ouvris les boîtes dans lesquelles j'avais enfermé mes larves des *Embia*, et sur six de ces larves je n'en trouvai qu'une seule qui se fût transformée en insecte parfait. Quant aux autres, elles étaient mortes, et n'avaient pu résister à une si longue captivité."

Later on, in the 'Annales de la Société Entomologique de France' for 1859, pp. 441–444, M. Lucas returned to the subject. The greater part of his paper is only an extension of the notes above quoted; but there is some additional matter, and of importance. He says, "Quant à la matière soyeuse sécrétée par les larves de l'*Embia mauritanica*, elle est fournie pendant toute l'existence de ces larves, et cette matière n'est pas seulement destinée à leur servir d'abri, mais elle est encore employée à prendre les insectes qui servent à la nourriture de ces larves carnassières. En effect, si l'on observe ces fourreaux placés sous les pierres, on remarque que, dans les environs de ces habitations les larves de ce singulier Névroptère ont le soin de disposer çà et là des fils de soie qui sont autant de piéges destinés soit à prendre les insectes, soit à les avertir de leur présence." This statement was copied in M. Maurice Girard's excellent 'Traité élémentaire d'Entomologie,' tome ii. (fasc. 1) p. 295, published in 1876.

Dr. Hagen, writing in the 'Stettiner entomologische Zeitung' for 1849, p. 56, said that nothing had then been recorded as to the habits; but in the Verhandlungen des zool.-botanischen Gesellschaft in Wien' for 1866, p. 222, he alludes to M. Lucas's statement (in 'Ann. Soc. Fr.'), and he says he possesses a larva (probably of *E. Savignyii*) found under a stone at Athens. I have a larva of *E. Solieri* found by Mr. Pascoe at Hyères under a stone; so that this habit is evidently general, but decidedly not exclusive.

From the above-given extracts it will be noticed that M. Lucas states distinctly that the larvæ are carnivorous, and also that the webs serve the double purpose of entangling the insects that are used for food and of warning the *Embia* of the presence of insect enemies; but I fail to understand any direct or implied assertion that he had seen insects actually caught in the webs or being devoured by the *Embia*. Both the larvæ and nymphs of the species found on the orchids spun silken tunnels, not at all of the nature of spiders' webs, but similar to those formed by many Lepidopterous larvæ, and which serve them as a protection from

their enemies; and the analogy is the more complete because the silken galleries are not perfect tubes, but more of the nature of coverings, the larva being protected above and able to feed on the surface of the vegetable matters on which it rests at the same time. Having in mind M. Lucas's assertions, I certainly doubted if the *Embia* larvæ caused any injury to the orchids; but having seen pieces of roots, placed in a box with the larvæ, freshly gnawed, I now suspect that a mistake has been made as to the supposed carnivorous habits of the species of the group. and that in reality they are vegetable feeders, as are the Termitidæ; for the latter will sometimes attack *growing* vegetable materials. There still, however, remains a difficulty in the common habit in most of the species of living *under stones*, in which localities almost the only vegetable matters that could serve them for food are the *mycelia* of fungi or ordinary fibrous roots.

Systematic Position, Structure, &c.

It is possible that there is no more difficult, unsatisfactory, and (I might add) thankless task than that of having to suggest the sequential position of any group in the so-called Pseudo-Neuroptera. Latreille, the founder of the genus *Embia*, placed it as a second genus in the subfamily Termitinæ. But I think Westwood happily seized upon its position as between the Termitidæ and Perlidæ. Burmeister, who justly erected these insects into a family (Embidæ), separated the White Ants from the Stone-flies by (*inter alia*) the highly specialized Dragonflies *. I do not think the relationship between *Termes* and *Embia* is so close as has generally been accepted. *Embia* evidently is not subject to those polymorphic conditions so characteristic of *Termes*, and wants its quadrifid labium (it is bifid in *Embia*). It has also much of the external form of the Perlidæ, especially of the genus *Leuctra* (which it resembles also in its extreme agility); and external form is not always to be disregarded in searching for affinities. But there are other and wide discrepancies; and the only object of these remarks is to suggest that *Termes* and *Embia* have less in common than is generally supposed.

* It is scarcely worth while to seriously notice Rambur's extraordinary arrangement. The Embidæ follow the Termitidæ; but the Perlidæ, with utter disregard of all affinities (excepting aquatic habits), are placed between the Sialidæ and Phryganidæ, with all the true Neuroptera Planipennia intervening between *Termes* and *Sialis*.

In Gerstäcker's system *Termes* precedes *Blatta*, and is separated from *Embia* by the whole of the true Orthoptera. This is a radical change; but I am disposed to agree with this author in considering *Termes* more nearly related to *Blatta* than the former is to *Embia*.

With regard to the sexual differences in the Embidæ, Westwood, forty years ago, remarked, "*sexus differentia latet.*" This obtains almost equally now; and I am not able to throw much light upon the subject. M. Lucas dissected several examples of his *E. mauritanica*; and all were apparently females. He speaks (Expl. d'Algérie) of asymmetry in the caudal processes in all the examples examined, the basal joint of the left process being much broader and more flattened than the right, and asks if this be a sexual character. I think not, and believe the asymmetry is almost (if not quite) universal in the family. All species examined by me possess it in a more or less marked degree. In some examples there is a slender spiniform process between these articulated side processes; but the materials at hand are too limited to enable me to decide if it represents the intromittent organ, or is common to both sexes*.

Respecting the genera of Embidæ, Westwood (as before stated) divided *Embia* into two sections and three subgenera, of which I reproduce the diagnoses:—

Sectio 1. Palpi maxillares 5-articulati. Antennæ thorace breviores, articulis subtus 20.

Subgenus 1. Antennæ 15-articulatæ; alæ nervo 3tio interno cum 4to nervis transversis connexo, hoc trifido. EMBIA, *Lat.*

Subgenus 2. Antennæ 11-articulatæ, articulo ultimo apice submammillato; alæ nervo 3tio interno cum 4to nervis transversis haud connexo, hoc bifido. OLIGOTOMA, *W.*

Sectio 2 (subgenus 3). Palpi maxillares 4-articulati. Antennæ corporis fere longitudine, articulis 32. Alæ nervo 4to interno trifido. OLYNTHA, *Gray.*

For my part I am disposed to consider the genera *Embia* and *Olyntha* identical, at any rate on the characters above given; for the maxillary palpi of *Olyntha* are 5- (not 4-) jointed (I have exa-

* In *Oligotoma Saundersii* this spiniform process has a small tooth before the apex on its lower side. I do not see the process in all the examples; hence it may perhaps be sexual, and possibly is the intromittent organ.

mined the type), and the length of the antennæ is scarcely more than a specific character. *Oligotoma* I regard as distinct on account of the different neural characters. I feel sure that the characters given for the antennæ of *O. Saundersii*, viz. "*antennæ* 11-*articulatæ, articulo ultimo submamillato*," are incorrect, and that these organs were broken in the example which served for type. I have six individuals of *O. Saundersii*: the antennæ are mostly broken; but in one I see clearly nineteen joints, and think that is the normal number; in others the submamillate apical structure is apparent, but this results from the organs having been broken, the small apical projection being in fact the basal portion of the succeeding joint. Rambur ('Hist. Névrop.' p. 311) states that his *Embia Latreillii* is evidently allied to *O. Saundersii*, but has eighteen joints to the antennæ: there can, I think, be no doubt that the two are absolutely identical.

Putting on one side, then, the characters given by Westwood for the palpi and antennæ, it appears to me that only two genera can be defined with certainty at present, as follows:—

1. Alarum sector ("nervus 3tius") trifidus, cum cubito ("nervo 4to") per venulas transversales plus minus connexus. EMBIA (*cum* Olyntha).

2. Alarum sector bifidus, cum cubito per venulas transversales haud connexus. OLIGOTOMA.

Distribution of the Family.

Distribution in time may be dismissed with the remark that the larva of a species (*Embia antiqua*, Pict.) has been noticed fossil in amber.

As regards existing distribution, the species mostly inhabit the warm regions of both hemispheres. One (or more) inhabits the Mediterranean region of Europe. I have one from North Persia. India has one or more species. The group occurs in North Africa, also in Mauritius and Madagascar, and, no doubt, also in East Africa; for forms have been found enclosed in copal. Several are found in Central and Tropical South America; but nothing has been noticed from Australia.

Number of Species.

Three only were noticed by Westwood in 1837; and at present probably not more than a dozen species are in collections; for it

is practically certain that several supposed species should rank only as synonyms.

I add the descriptions of several species that appear to be new:—

Embia Batesi, sp. n. Nigra vel nigro-picea. Prothorax flavo-ferrugineus. Antennæ nigræ, 20-articulatæ, articulis quinis ultimis flavidis, pallide pilosis. Alæ breves, latæ, nigro-fuscæ, albido 5-striatæ. Long. corp. 7 millim. Expans. alar. 41 millim.

Hab. Brasilia (*Bates*).

Black or blackish fuscous with a piceous tinge, the prothorax above and beneath, and the head beneath (excepting at the sides) pale reddish yellow. Antennæ with 20 joints, black, clothed with grey hairs; but the apical 5 joints are pale yellowish clothed with pale hairs, the tip of the terminal joint fuscescent; the 3rd joint almost as long as the 1st and 2nd united; the 4th and 5th short, submoniliform; the succeeding joints more or less elongate-oval. Maxillary palpi black, short, the 3rd to 5th joints somewhat ovate. Legs blackish, with a piceous tinge, clothed with greyish hairs; coxæ yellowish. Abdomen also with a piceous tinge, the hairs blackish; caudal appendages long, especially the 2nd joint, which is strongly flattened, obtuse, and obscure yellowish, with black hairs. Wings short and very broad, especially the posterior pair, in which the apex is almost semicircular; they are dark fuscous; the membrane set with minute blackish tubercles; five very narrow whitish longitudinal lines; neuration fuscous, but the subcosta and radius distinctly dark claret-colour; four nervules between the radius and the upper branch of the sector, discoidal cell broad, closed; and there is a transverse nervule below this cell connecting it with the upper cubitus; in the posterior wings the discoidal area has two nervules.

I have one example collected by Mr. Bates on the Amazons. I do not think it can be identical with *Olyntha ruficapilla*, Burm. (of which *Embia Klugi*, Ramb., is thought to be a synonym); for the latter has the head, as well as the prothorax, wholly reddish. It is the broadest-winged species known to me.

E. Salvini, sp. n. Atra, subopaca. Antennæ (mutilatæ) castaneæ, fusco hirsutæ; cuticulo basali fusco-nigro. Alæ angustatæ, nigro-fuliginosæ, albido 5-striatæ; venis fuscescentibus. Long. corp. circa 7½ millim. Exp. alar. circ. 13 millim.

Hab. Amer. Centr.

Body deep black, subopaque, very sparingly clothed with black

hairs. Head with a large shallow depression on the middle of the disk above; labrum slightly castaneous. Maxillary palpi having the four basal joints short, nearly equal (or the 4th slightly longer than the 3rd), not much longer than broad; 5th as long as the 1st to 3rd united, subacute: the colour of these palpi is blackish; but the sutures are paler, and they are clothed with paler hairs. Labial palpi having the 3rd joint as long as the 1st and 2nd united. Mentum very large, the sides rounded, apical margin shallowly concave; the edges are slightly thickened and raised, the median portion somewhat elevated; but otherwise the organ is shallowly concave. Antennæ (mutilated in the type, all lost beyond the 10th joint) with a stout black basal joint, 2nd small, 3rd more than twice the length of the 4th, those succeeding long, elongate-pyriform; the colour (excepting the basal joint) is castaneous, becoming gradually darker (hence probably blackish towards the apex, but with the usual pale apical portion); they are clothed with long fuscous hairs. Pronotum raised, much narrowed anteriorly, the side margins slightly flattened; and there is a faint median longitudinal impressed line; before the anterior margin is a very deep transverse sulcus. Mesonotum rather longer than broad. Metanotum nearly quadrate. Caudal appendages very long, brownish, clothed (as is the apical portion of the abdomen) with yellow hairs; between them is a stout, yellowish, simple, spiniform process. Legs shining blackish, clothed with yellowish hairs, the tarsi somewhat castaneous. Wings narrow and elongate, smoky blackish, with five longitudinal, narrow, whitish lines, whereof the 4th becomes confluent with the 5th before its apex in the anterior wings; neuration fuscescent; radius and subcosta blackish with pale margins; two transverse nervules between the radius and sector; discoidal cell very long, closed; and there is a second transverse nervule in the discoidal area before the apex; two transverse nervules between the discoidal cell and cubitus, somewhat toward the base.

One example (♂?) from Central America, taken by Mr. Salvin at Chinautta, at an elevation of 4100 feet.

Dr. Hagen, in his 'Neuroptera of N. America,' p. 7, indicated a larva from Cuba. Later on, in his 'Synopsis Embidinorum Synonymica,' he applied the name of *Olyntha cubana* to this, and says he then possessed the imago; but no description is given. Supposing the larva to be full-grown, the size given (length 4 millims.) would appear to indicate a smaller species than *E. Salvini*.

E. PERSICA, sp. n. Nigra subnitida. Caput vix in medio piceo tinctum. Pronotum brunneum. Antennæ nigræ, basin versus pallido cinctæ, 24-articulatæ; articulis duobus ultimis flavidis. Alæ angustæ, fuliginosæ, albido 5-striatæ; venis fuscis. Long. corp. circa $9\frac{1}{2}$–$10\frac{1}{2}$ millim. Exp. alar. $13\frac{1}{2}$–15 millim.

Hab. Persia septentrionalis.

Black. Head somewhat shining, sparingly clothed with greyish hairs; in form broad, subquadrate, almost truncate posteriorly, with the hinder angles rounded; on the middle of the disk is a large, nearly circular depression tinged with piceous. Maxillary palpi having the 1st joint longer than the 2nd and 3rd, the 4th and 5th very stout, the 5th obtusely oval, scarcely longer than the 1st. Labial palpi very short and stout, the terminal point very obtuse. Mentum small, transversely subquadrate with straight sides and truncate anterior margin. Antennæ scarcely longer than the head and pronotum, 24-jointed; basal joint short and thick, 2nd, 4th, and 5th scarcely longer than broad, the 3rd somewhat longer (the 2nd to 6th each with a narrow yellowish ring at the apex); afterwards they become longer, but scarcely one half longer than broad; the terminal two joints dingy yellowish; otherwise the colour is black, clothed with greyish hairs. Mandibles testaceous. Pronotum short, considerably narrowed anteriorly, with a transverse impressed line; colour brown, clothed with greyish hairs: prosternum distinctly pale yellow. Meso- and metanota shining black, the former oblong, the latter nearly quadrate. Legs dark piceous, clothed with greyish hairs. Abdomen blackish piceous, paler beneath, clothed with yellowish-grey hairs; caudal appendages short, the second joint brownish, clothed with yellowish hairs. Wings narrow, dark fuliginous; neuration fuscescent, the space between the subcosta and radius dark fuscous; and these veins are somewhat vinous in colour, and the radius is narrowly margined with whitish on its lower edge; five narrow whitish longitudinal lines: discoidal cell very long, closed, and then an additional transverse nervule in its area nearer the apex; two or three transverse nervules between the radius and upper branch of the sector, and one between the lower branch of the sector and the cubitus.

I have three examples (all ♀?) from Shahrud, North Persia, collected by Herr Christoph.

E. Solieri, Rambur (from the south of Europe), of which, I think, only the larval form has been observed, appears to have

twenty-one joints to the antennæ; it can hardly be identical with this Persian species. Hagen indicates another species as *E. nigra* (but without description), from Egypt, which he considers distinct both from *E. Savignyii* and *E. Solieri*.

Obs.—The figure of *E. Savignyii*, given by Savigny ('Desc. de l'Egypte'), appears to have been taken from an individual with partially aberrant neuration. It will be noticed that in the right anterior wing (copied by Westwood) the lower forked branch of the sector has the upper prong of the fork again furcate; this is not indicated in the left wing.

Oligotoma Michaeli. Atra, subnitida; capite infra in medio paulo rufescente. Antennæ 24-articulatæ, nigræ; articulis 5–6 ultimis flavidis, ultimo parvulo. Pedes nigri, fusco-pilosi, tarsis subtestaceis. Alæ nigro-fuscæ, albido 4-striatæ; venis plerumque nigris. Long. corp. $10\frac{1}{2}$ millim. Expans. alar. 18 millim.

Hab. in India orientali.

Deep black, somewhat shining. Head elongate, with a large, nearly circular, shallow depression on the disk above; eyes large; beneath, the portion below the labium, joining on to the neck, is reddish. Antennæ black, with black hairs, 24-jointed, the 1st joint large but short, 2nd very small, 3rd nearly as long as the 1st and 2nd united, the succeeding two or three joints rather short; but afterwards they became elongate; gradually decreasing in length near the apex, the apical five joints yellowish, and the 6th from the apex also tinged with yellow, the terminal joint small and obtuse: in length the antennæ nearly equal the head and thorax united. Maxillary palpi stout, the last two joints longer than the others. Pronotum much narrowed in front, nearly twice as long as broad. Meso- and metanota nearly equal. Legs black, with blackish hairs; knees and tarsi somewhat testaceous. Abdomen black, with black hairs; caudal processes long, but very asymmetrical, black, with black hairs; the right has the basal joint very broad, nearly quadrate; whereas in the left it is slender and fully twice as long; a slender process with piceous apex projects from the base of the right; ventrally is a large triangular projection of the last segment, concave above. Wings narrow, dark smoky fuscous, the membrane transversely rugose (but not visibly tuberculate); the costal margin appears darker in consequence of the thick, black, coalescent subcosta and radius; the oblique postcostal vein also thickened and deep black; the

sector deep black and strong, the other veins fine and inconspicuous; 4–5 evident pale costal veinlets, and three veinlets in both pairs between the radius and the upper branch of the sector; but there are no other transverse veinlets; hence the discoidal cell is open; four very narrow whitish longitudinal lines.

A well-grown larva is 12 millims. long. The antennæ much shorter than in the imago. The colours generally lurid-fuscous rather than blackish, with the posterior portion of the head, the whole prothorax, and the legs more or less testaceous; and the whole underside is pale; the abdominal segments above with a brownish tinge, clothed with sparse yellowish hairs; the caudal appendages present; just the same asymmetry as in the imago.

A starved "nymph" is only 9 millims. long. The colours similar to those of the larva: and the form also generally similar; but the legs are more slender (as in the imago), the asymmetry in the caudal appendages less striking (is it of the same sex?). The rudimentary wings elongate-oval, with evident neuration, characteristic of the genus; the anterior extending to the posterior margin of the metanotum, the posterior to the posterior margin of the second dorsal abdominal segment.

This is the species alluded to at the commencement of this paper, found by Mr. Michael in one of his hothouses among plants of *Saccolobium retusum* imported from India. In its wing-structure it agrees generically with *O. Saundersii*, which is also an Indian species.

DESCRIPTION OF PLATE XXI.

Fig. 1. *Oligotoma Michaeli*, a full-grown larva shown about six times its natural size.

2. The nymph-stage of the same insect (possibly in a starved condition), also enlarged six times nat. size. The dotted lines on the right hand of the figure denote wing-outline as when expanded.

3. The perfect insect of *O. Michaeli*, magnified six times nat. size.

The Anniversary Address of the President, Professor Allman, M.D., LL.D., F.R.S.

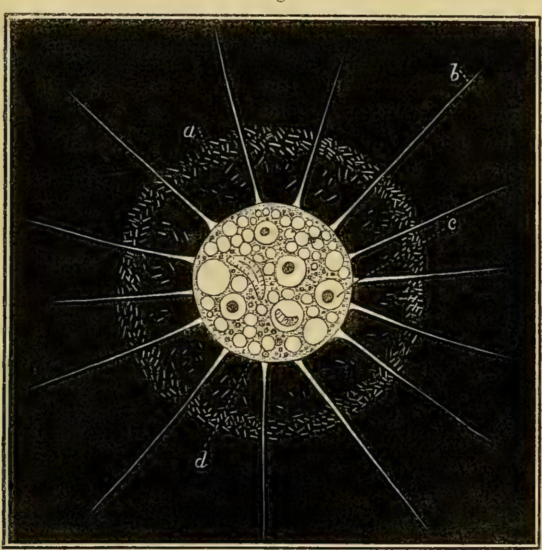
Recent Researches among some of the more simple Sarcode Organisms.

[Read May 24, 1877.]

(Second Notice.)

In my last year's Address I attempted an exposition of researches among certain lower sarcode organisms to which within the last few years the attention of zoologists had been directed. The subject, however, proved to be so large, and the activity which had prevailed in it so great, that I found it impossible to do justice to it within the limits of a single address. I was therefore compelled to leave untouched much of what was necessary for a complete exposition, and I purpose on the present occasion to take up the subject where I was then obliged to leave it.

Fig. 1.



Heliophrys variabilis, Greeff (*Nuclearia simplex*, Cienkowski), under slight compression. *a*, outer layer; *b*, pseudopodia; *c*, nucleus; *d*, vacuolæ. (After Greeff.)

Cienkowski * has given the name of *Nuclearia simplex* to a re-

* "Beiträge zur Kenntniss der Monaden," Arch. f. mikr. Anat. 1865.

markable sarcode organism which lives on the contents of Alga-cells, which it sucks out in the manner of a *Vampyrella*. It would seem to be identical with the rhizopod to which Greeff gave the name of *Heliophrys variabilis* (figs. 1 & 2)*, and F. E. Schulze that of *Heterophrys varians*†. It has certain obvious relations with the *Heliozoa*, from which, however, it differs in its great variability of form, the spherical or homaxial shape so characteristic of the *Heliozoa* being only occasionally assumed by it.

It is described by Cienkowski as an *Amœba* with fine, pointed, instead of lobose, pseudopodia, and with numerous nuclei in its protoplasm. The protoplasm is very transparent, and besides the nuclei encloses a multitude of vacuoles, which slowly appear and disappear without showing the sudden collapse which is characteristic of the true pulsating vacuoles.

Some of the specimens studied were observed by Cienkowski to have become surrounded by a granular spherical envelope, and to have thus passed into what he regards as probably a resting-stage.

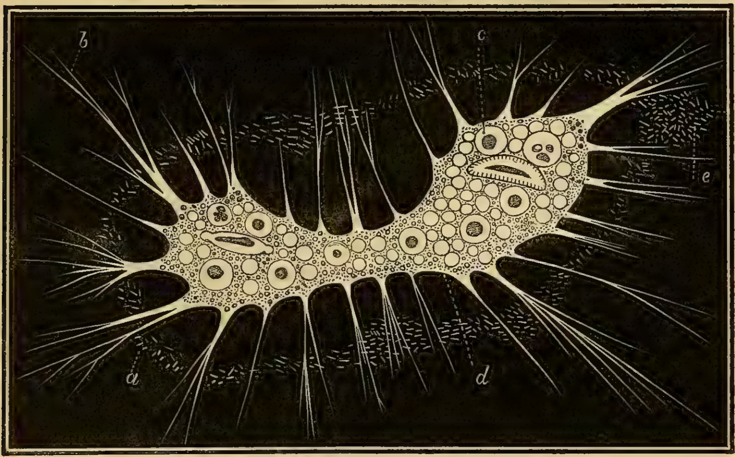
Cienkowski places *Nuclearia*, along with *Vampyrella* &c., in his group of "Monadinæ;" but its structure, and especially the presence of nuclei in its protoplasm, will not justify its association with organisms which are essentially cytodes.

Greeff describes his *Heliophrys variabilis*, which he finds abundant in both stagnant and running water during spring and early summer, as varying from a sphere or circular disk (fig. 1) to an irregular more or less elongated and compressed form (fig. 2). He further describes it as surrounded by a hyaline and homogeneous layer, whose surface is set with short rod-like granules, and which is traversed by the long pointed pseudopodia on their way from the proper body in which they originate to the external water. The numerous nuclei which are brought into view by moderate compression consist of a delicate hyaline capsule with a darker homogeneous central spherule.

A closely allied, if not identical, organism has been described by Hertwig and Lesser under the name of *Leptophrys*. It is a multinucleated greatly vacuolated protoplasm mass of very variable outline, but usually in the form of a delicate veil, which spreads over the stage of the microscope, and is so thin and transparent as to allow objects which lie under it to be distinctly seen. Its edges usually flow out into lobes, from which the fine pointed pseudopodia radiate.

* Arch. f. mikr. Anat. xi. † "Rhizopodenstudien," Arch. f. mikr. Anat. xi.

Fig. 2.



Heliophrys variabilis in the act of creeping. It has passed from a globular form to that of an irregular disk. The pseudopodia have become divided. *e*, rod-like granules of the outer hyaline layer. Other lettering as in preceding fig. 1. (After Greeff.)

Hertwig and Lesser, Eilhard Schulze, and Archer have made us acquainted with a large number of monothalamian Rhizopods of fresh water.

In almost all the freshwater forms the presence of a nucleus can be demonstrated without difficulty; and resting on the belief universally entertained that the marine forms known in general by the name of Foraminifera, whether monothalamian or polythalamian, are, with one or two incompletely established exceptions, destitute of a nucleus, Hertwig and Lesser saw in this difference grounds for the association of the freshwater monothalamic Rhizopods into a special group, to which they limited the name of *Monothalamia*.

The quite recent discovery, however, by Hertwig himself* and by F. E. Schulze†, of a nucleus in several genera of Foraminifera, and the great probability of its occurrence throughout the whole, take away the only important structural difference between the two groups, and render it necessary to embrace both in a single

* "Bemerkungen zur Organisation und systematischen Stellung der Foraminiferen," Jenaische Zeitschrift, 1876.

† "Ueber den Kern der Foraminiferen," Archiv für mikr. Anat. 1876.

class. To this class Hertwig, in his most recent memoir*, has assigned the name of *Thalamophora*.

The researches which have thus from various quarters been brought to bear on these organisms have made known to us many new facts, and enable us to give a more complete picture of them than had been hitherto possible.

The *Thalamophora* are organisms whose soft bodies are formed of sarcode or protoplasm which envelopes one or more nuclei, and which for the purposes of locomotion and the prehension of nutriment has the power of emitting pseudopodia. Receptacles of liquid in the form either of contractile or of non-contractile vacuoles are almost always present. All *Thalamophora* are enveloped by a shell or test, which is either purely chitinous or is hardened by calcareous deposits, or incrusted by siliceous fragments. In its shape it belongs to the "monaxial fundamental form" of Haeckel, having a main axis, at one extremity of which is the oral orifice of the test. In the simplest cases this main axis is straight (*Gromia*, *Microgromia*, *Euglypha*, *Nodosaria*, &c.), but in most of the marine forms it is regularly curved in a spiral (*Miliola*, *Rotalia*, *Polystomella*, &c.), while in some the regular curvature is masked by a subsequent irregularity of growth.

In this monaxial shape and in the constant position of the oral orifice of the test in relation to the main axis we find the essential character by which the *Thalamophora* are distinguished from the *Heliozoa*. These, instead of being monaxial, are "homaxial" (Haeckel); that is, all their axes being of equal value, their proper form is that of the sphere. Further, when a test is present in the Heliozoa, this has either no constant opening, or the openings are numerous and placed without any definite relation to an axis.

By consecutive constrictions of the test at right angles to the main axis polythalamic forms are produced. Carpenter had already shown that the characters derived from the polythalamic or monothalamic condition of the shell are of but slight systematic value; and this view is fully borne out by the most recent researches, which make it evident that the number of the nuclei in the Foraminifera do not stand in any direct relation to the number of the chambers—in other words, that each newly formed chamber does not necessarily contain a newly formed nucleus. The polythalamic forms therefore are not be regarded as colonies of monothalamic forms.

* *Op. cit.* Jenaische Zeitschrift, 1876.

A much more important character available for the definition of the higher groups had been shown by Carpenter to be derivable from the structure of the shell. In some this is throughout perforated by minute canals, in others provided only with the single comparatively large terminal orifice, or occasionally with a terminal group of orifices, or in rare cases with two large orifices, one at each end of the main axis. The *Thalamophora* thus admit of a primary division into the *Imperforata* and the *Perforata*, as insisted on by Carpenter.

It may be questioned whether the presence of a test affords a character of sufficient importance to justify its being made the basis of such higher groups; whether, for example, *Arcella* should be far separated from *Amœba* on the grounds that in one case the sarcode is naked, in the other enveloped by a test.

To this character Carpenter assigns a very subordinate value. We must not, however, lose sight of the fact that the formation of a test,—of a true test, at least, as distinguished from a mere pellicle which yields to such changes of form as the sarcode may undergo, —brings with it modifications in some of the most striking characters of the naked protoplasm; for not only are the pseudopodia, even in the *Perforata*, necessarily limited by it to definite points of the body, but it substitutes a definite outline for the indefinite and constantly changing outline of such naked organisms. The importance of this definiteness of outline is shown by the great symmetry which is in almost every case presented by it, while the shell itself often possesses an elaborate structure, as seen in the hexagonal areolæ between the inner and outer tables of the shell in *Arcella* and the beautiful tessellated structure in *Quadrula* and *Euglypha*.

Hertwig and Lesser have discovered many new freshwater representatives of the *Thalamophora*, and have made known to us many important facts in their structure and life-history. All the freshwater *Thalamophora* hitherto met with are monothalamic (figs. 4, 5, &c.), and, if we except Archer's genus *Diaphoropodon*, are also imperforate. Their test is of a conical or elliptical shape, and is for the most part of a firm and solid consistence, though occasionally membranous and flexible. It is either a pure product of excretion, or in addition to this it may become more or less incorporated with foreign bodies, such as minute fragments of silica or shells of Diatomacea. When it consists of a pure excretion from the protoplasm-body it may be either perfectly smooth and

structureless (fig. 4), or it may present various kinds of structure or sculpture, often very elegant and characteristic (figs. 5, 7).

The soft protoplasmic contents of the test are in the freshwater *Thalamophora* almost always differentiated into a more granular portion and a more homogeneous portion. In those with a single orifice the granular protoplasm lies towards the anterior or oral end, the more homogeneous towards the posterior or aboral end. The posterior homogeneous protoplasm includes the nucleus, while in the anterior granular portion, or on the boundary between the two, lie numerous vacuoles. These are almost always rhythmically contractile, and are constant in number and position in each species. When there are two shell-orifices the nucleus lies in the middle point between them. In the *Arcellæ*, which present the condition very exceptional among freshwater *Thalamophora* of being multinucleate, the nuclei lie in the marginal part of the nearly disk-shaped protoplasm.

The characteristic form of the nucleus is that of a clear vesicle, which almost always includes a pale bluish nucleolus.

The pseudopodia present two important modifications. In one (figs. 4 & 5) they are cylindrical, blunt, unbranched, non-confluent, and usually destitute of granule-currents. In the other (fig. 6) they are very contractile delicate pointed threads, which repeatedly ramify and flow together, and present currents of granules in their interior. Between these two, however, there are numerous intermediate conditions, but the two main forms, the blunt and the pointed, may always be distinguished; and Hertwig and Lesser accordingly employ these characters in the definitions of some of their higher groups, adopting from Carpenter the name of *Lobosa*, which they assign to the forms with blunt pseudopodia, and assigning that of *Rhizopoda* to those in which the pseudopodia are pointed.

The name of "Rhizopoda," in the special sense in which it is here employed by Hertwig and Lesser, is certainly objectionable, and from its being very generally used with a different significance would tend to introduce confusion into our definitions. F. E. Schulze uses in the same sense the more appropriate designation of "Filifera;" but Carpenter had long ago employed that of "Reticularia" to indicate those forms whose pseudopodia are long and filiform and tend to unite with one another into a network (*Gromia* and the so-called Foraminifera). As forms occur, however, with filiform pseudopodia which show no tendency to anastomose, the designation "Filifera" is of more general application.

Another important systematic character is derived from the number of terminal or oral orifices in the test, though this, in consequence of the great inequality of the two groups based upon it, loses much of the practical value which it would otherwise possess in classification. In almost every case there is but a single such orifice (figs. 4, 5, 6, &c.). In some rare cases, however, there are two, one situated at each end of the main axis (fig. 8). It is these conditions which Hertwig and Lesser designate respectively by the names of *Monostomatous* and *Amphistomatous*.

Among the freshwater *Thalamophora* with blunt pseudopodia (*Lobosa*) Hertwig and Lesser* have made some interesting observations on the long-known and widely distributed *Arcella vulgaris*, one of the largest and best fitted for observation of the freshwater *Rhizopoda*. They have corrected the descriptions of the structure of its shell given by previous observers, and have brought together its essential characters in a more exact generic diagnosis than had been hitherto attempted.

Its shell, which is a pure excretion from the contained protoplasm, has its main axis very short in proportion to the lateral axes; and the elongate form so characteristic of the freshwater *Thalamophora* becomes thus shield-shaped with the orifice for the pseudopodia in the centre of the flat side, which, during locomotion, is turned towards the supporting surface. Its walls, as now shown by Hertwig and Lesser, are composed of two parallel plates, an outer and an inner, which are united to one another by an intervening structure with hexagonal chambers like those of a honeycomb.

Besides containing contractile vesicles the protoplasm is very exceptional in containing numerous nuclei. The body does not entirely fill the shell, but forms a disk-shaped mass of protoplasm lying on the lower wall and having the contractile vesicles and nuclei immersed in its peripheral parts. It is connected with the upper wall of the shell by filiform processes, which in young specimens are richly developed, repeatedly branch and anastomose, and form a sort of pseudopodial net over which the protoplasm-granules travel to and fro.

An encysting process, apparently connected with reproduction, has been observed by them. In this the protoplasm becomes surrounded by a globular cyst which lies within the shell close to the orifice. The coarsely granular and opaque condition of the protoplasm rendered it impossible for them to discover any thing

* Arch. f. mikr. Anat. Band x. Suppl.-Heft.

regarding the condition of the nuclei; nor were they able to follow the process through any further stages.

They have also studied a phenomenon which has been regarded by other observers as a conjugation of two individuals, but which Hertwig and Lesser interpret as a case of reproduction by spontaneous division. In this the appearance presented is that of two individuals in union with one another by their pseudopodial surfaces, where they are connected by a broad bridge of protoplasm, which stretches from the soft body of one animal to that of the other. One of these connected individuals has always the usual dark brown shell, while in the other the shell is clear and colourless. Across the connecting bridge the protoplasmic contents of one shell pass over into the other until the former is nearly emptied. Then the direction of the stream is reversed and the nearly emptied shell becomes filled at the expense of the other. This interchange of the contents now repeats itself, and thus goes on rhythmically for some time, when a period of rest sets in, the protoplasm bridge becomes gradually thinner, and finally breaks across, and the two hitherto united *Arcellæ* become detached from one another, each composed of nearly an equal part of the originally single protoplasm mass, which, according to the interpretation of Hertwig and Lesser, has thus become divided into two independent segments.

Bütschli has described in *Arcella* a somewhat different phenomenon, which he regards as a true conjugation*. In this three individuals, all with dark brown shells, were observed to be in union with each other by means of bridges of protoplasm which proceeded from the shell-orifices. On the day following the separation of the conjugating *Arcellæ* he noticed that in one of the individuals the protoplasm-body had withdrawn itself for a considerable space from the shell-wall, and that in the liquid which filled the interval a multitude of *Vibrio*-like bodies swarmed, while in close contact with the dorsal surface of the protoplasm there lay numerous flat disk-shaped masses of protoplasm. After some time these showed lively amœboid movements, and crept about between the body of the parent animal and the shell-walls. These amœboid bodies ultimately crept out through the shell-orifice. They contained a contractile vacuole and a clear nucleus, and moved by the protrusion of short very blunt processes. Bütschli was not able to follow their further development; but he does not hesi-

* Arch. f. mikr. Anat. vol. xi. (1875) p. 459, pl. xxv.

tate to regard them as the proper brood of the *Arcella*, and compares their formation with that of the budding of zoospores from the surface of the body in *Noctiluca* as described by Cienkowski*.

We owe to Hertwig and Lesser† and to Franz Eil. Schulze‡ two papers on *Pseudochlamys patella* (fig. 3), in which they supplement and correct the description of this rhizopod as given by Claparède and Lachmann. Its shell is of a brownish-yellow colour, shaped like a watchglass, so as to be widely open on the inferior surface. Here, according to Hertwig and Lesser, a delicate structureless membrane stretches across the opening, which it closes, except in

Fig. 3.

Pseudochlamys patella.

Viewed from below, with opposite margins of the test folded in, and with a protruded finger-shaped pseudopodium.

(After F. E. Schulze.)

a small central space which remains open for the passage of the pseudopodia. Schulze, who makes no mention of this membrane, describes indications of structure in the shell towards its summit which recalls that of *Arcella.*

The animal possesses the remarkable power of bringing into juxtaposition the opposite margins of the wide shell-opening, thus completely changing the form of the shell and making it resemble the bivalve shell of a Lamellibranchiate mollusk or of a *Cypris.* This approximation of the margins is evidently brought about by the contractility of the contained protoplasm, while the return to the previous condition would seem to result from the elasticity of the shell. Schulze has noticed in some cases special bands of protoplasm passing from the circumference of the body to the margin of the shell to which they are attached. He believed they act in a way analogous to that of muscles in regulating the form of the orifice.

The protoplasm-body is finely granular, and contains in its periphery a great number of contractile vesicles, while there is a

* Arch. f. mikr. Anat. vol. ix. p. 47. † *Id.* vol. x. Suppl. ‡ *Id.* vol. xi.

single more central nucleus. Besides a single (seldom more) thick finger-shaped pseudopodium like those of *Arcella*, Schulze describes numerous rounded tubercle-like processes, which do not seem to project beyond the orifice.

As in *Arcella*, an encysting process has been observed, but has not been followed to its results.

The authors believe that Greeff has incorrectly assigned to the genus *Amphizonella* the form which he names *Amphizonella flava*, and which they regard as identical with *Pseudochlamys patella*.

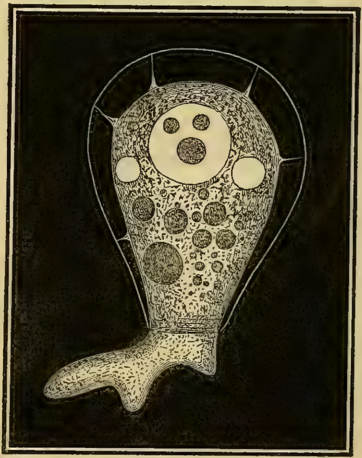
The *Pyxidicula operculata* of Ehrenberg is another nearly allied form. Claparède and Lachmann, followed by Carter, had placed this rhizopod in the genus *Arcella*; but Hertwig and Lesser, relying on the fact of the shell being destitute of the characteristic structure of that of *Arcella*, restore Ehrenberg's name.

Fig. 4.

Hyalosphenia lata.

Viewed from the broad side, with a slightly divided finger-shaped pseudopodium.

(After F. E. Schulze.)



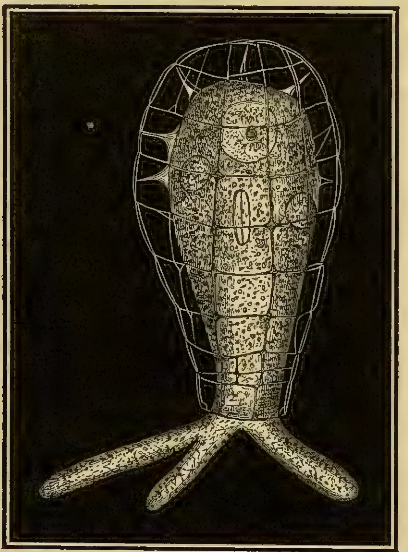
Hyalosphenia lata, F. E. Schulze (fig. 4)*, is another freshwater representative of the *Thalamophora*. It has a compressed pyriform test and thick finger-shaped pseudopodia. The test is a simple hyaline case without any trace of structure. Included in the broad aboral portion of the protoplasm is a large spherical nucleus containing numerous nucleoli, and just in front of it lie the pulsating vacuoles, which are usually two in number. There is usually only a single finger-shaped pseudopodium emitted from the orifice of the test. The pseudopodium, though belonging to the lobose type, encloses fine granules, whose flowing movements are easily seen in the axis of the pseudopodium.

* F. E. Schulze, *loc. cit.*

Among the *Thalamophora* with thick, blunt, non-anastomosing pseudopodia, must also be included a beautiful freshwater rhizopod originally described by Wallich* under the name of *Difflugia symmetrica*, and more recently studied by Fr. Eil. Schulze, who has made it the type of an independent genus to which he assigns the name of *Quadrula* (fig. 5)†.

The test is pear-shaped, laterally compressed so as to be elliptical in transverse section, and presents a definite sculpture caused by its being composed of a great number of hyaline square plates which touch one another by their edges. *Quadrula* is nearly allied to *Hyalosphenia*, from which it differs mainly in possessing a definitely sculptured test. The granular pro-

Fig. 5.



Quadrula symmetrica. Viewed from the broad side. (After F. E. Schulze.)

toplasm-body does not in general completely fill the test; and the space which intervenes between it and the test-walls is occupied by a clear liquid and traversed by thin bands of protoplasm.

In the centre of the more voluminous posterior or aboral portion of the body lies the large clear spherical nucleus with a very distinct dark nucleolus; and in front of this are the pulsating vacuoles, generally two in number. The pseudopodia are few, and are

* Ann. Nat. Hist. vol. viii. 1864. † Arch. f. mikr. Anat. vol. xi. 1875.

thick and finger-shaped and, like those of *Hyalosphenia*, enclose fine granules.

In the fact of its shell being composed of numerous juxtaposed plates *Quadrula* presents an obvious affinity with *Euglypha*, from which, however, its compressed form and, above all, its thick finger-shaped pseudopodia clearly separate it. In tests from which the protoplasm has disappeared detached plates similar to those composing the walls are frequently found either lying free or associated in bundles. A fact of quite a similar kind has been noticed in *Euglypha*.

Hertwig and Lesser have studied the *Difflugiæ* and have described a new species (*D. acropodia*) remarkable for the peculiar form of its pseudopodia, while they bring together the essential characters of the genus more exactly than had been hitherto done. The genus *Difflugia* was founded by Leclerc for freshwater *Thalamophora* with blunt pseudopodia, and whose test provided with a single opening is not a pure excretion of the protoplasm, but is formed of agglutinated foreign corpuscles—fragments of silica and shells of Diatomacea. The shell so constructed, however, has, as the new species examined by Hertwig and Lesser clearly shows, a membranous basis excreted by the contained protoplasm.

The *Difflugiæ* have a nucleus immersed in the posterior part of the protoplasm ; but no contractile vesicles have as yet been discovered. Like the Heliozoa they contain also in their protoplasm chlorophyl-granules, a fact of extremely rare occurrence among the *Thalamophora*.

In *D. acropodia* the pseudopodia differ from the finger-shaped processes of other *Difflugiæ* in consisting of broad plates of homogeneous protoplasm, which at some distance from the pseudopodial opening end in irregularly-shaped lobes with their contours cut into sharp segments. They owe their origin to the confluence of what were at first narrow lancet-shaped pseudopodia very like those of *Actinosphærium*, except in being destitute of granules. They form an obvious transition between the blunt pseudopodia of the *Lobosa*, and the pointed pseudopodia of those forms to which Hertwig and Lesser would confine the name of *Rhizopoda*, the *Filifera* of F. E. Schulze.

The siliceous fragments with which the test is set are usually so sparingly scattered as to reveal the thin basal membrane on which they are fixed.

The *Thalamophora* with pointed filiform pseudopodia (*Filifera*)

are much richer in genera and species than the *Lobosa*; and we have here, as in the *Lobosa*, forms in which the shell is a pure excretion from the protoplasm, and others in which it is strengthened by the incorporation of foreign bodies. The first group may be further subdivided into those whose shell is structureless, and those in which it is characterized by the possession of definite sculpture.

To those in which the test is a simple structureless excretion without the agglutination of foreign particles must be referred the genus *Gromia*, founded by Dujardin.

Its more or less spherical or oval test lies close upon the surface of the protoplasm-body; it is membranous, flexible, and inelastic, and through an opening at one end of its main axis the pseudopodia are emitted and form by their repeated branching and anastomoses a widely extended protoplasm-network. No contractile vacuoles have yet been found.

Gromia oviformis, on which Dujardin founded his genus, is a marine form. It has been made the subject of a careful study by Max Schultze, who, instead of the single nucleus which almost universally characterizes the freshwater *Thalamophora*, has found in the posterior part of its body numerous clear spherical vesicles filled with granules and regarded by him as nuclei.

A new species of *Gromia*, *G. granulata*, F. E. Schulze, has been studied by F. E. Schulze, who found it in fresh water attached to *Ceratophyllum* and other water-plants. It is a transparent and colourless species, with its clear protoplasm containing a multitude of strongly refringent granules, which at the periphery are disposed at nearly equal intervals, so that when seen through the transparent shell they give to this the appearance of being minutely punctate. Schulze describes a single nucleus lying in the posterior part of the protoplasm. It is a large, clear, spherical body, surrounded by a membrane, and having within it either a moderately large, spherical, strongly refringent nucleolus, or many less distinct dark corpuscles. This is pretty nearly the normal condition of the nucleus in the freshwater Thalamophora, and is so very different from the numerous vesicle-like bodies described by Max Schultze as nuclei in *Gromia oviformis* as to lead us to doubt the correctness of attributing to these last the significance of true nuclei.

The genus *Trinema*, founded by Dujardin for a freshwater Thalamophorous Rhizopod, to which he gave the name of *T. acinus*,

and which, under that of *Difflugia enchelys*, was subsequently described by Ehrenberg, has been recently studied by Hertwig and Lesser. It is provided with a firm structureless shell which does not closely invest the protoplasm. It has an elongate oval form, becoming wider towards the aboral pole. The shell-orifice instead of lying at the end of the main axis, lies laterally and oblique to it, and has its margins inflected inwards. The protoplasm-body consists of a posterior homogeneous portion and an anterior more granular portion. In the posterior is the nucleus with its nucleolus, and on the boundary between the posterior and middle third, lying in an equatorial plane, are the contractile vacuoles, which are always three in number. The filiform and pointed pseudopodia are destitute of granules and form no anastomoses.

Hertwig and Lesser describe a peculiar mode of cyst-formation in *Trinema*. They have frequently found specimens of *T. acinus* which contained in the posterior part of the shell a spherical cyst-like body filled with uniform strongly refringent granules. A nucleus with nucleolus were also generally visible in it. In some cases the cyst was seen to be invested by a double membrane, apparently analogous to the double investment observed by Hertwig and Lesser in the cysts of *Euglypha alveolata* (see the description of this rhizopod given below).

They have also found examples of *Trinema* in which the posterior part of the shell was no longer occupied by the protoplasm-body, which had the appearance of being truncated posteriorly. In one of these the otherwise empty space was nearly filled by a constantly rotating sphere. Whether the rotation was caused by cilia or flagella, they could not ascertain; but they believe that here, as in *Microgromia*, the detached body was formed by a self-division of the protoplasm, and is destined to become liberated as a swarm-spore.

Like many other freshwater Thalamophora, two individuals of *Trinema acinus* are often found united to one another by their pseudopodial orifices. No change has been noticed as the result of this union, which has probably nothing to do with reproduction.

Claparède and Lachmann consider the *Euglypha pleurostoma* of Carter as identical with Dujardin's *Trinema acinus*; and this view is accepted by F. E. Schulze, who attributes to *Trinema* a sculptured shell like that of *Euglypha*. With this identification Hertwig and Lesser do not agree. They believe that Carter has rightly referred his rhizopod to the *Euglyphæ*.

To the same group of freshwater filiferous Thalamophora belong the species referable to Claparède and Lachmann's genus *Plagiophrys*. Hertwig and Lesser correct and supplement the description of this genus given by Claparède and Lachmann, who, regarding it as destitute of shell, place it in their family of the Actinophryidæ. It is really provided with a delicate membranous flexible test, which is thrown into folds by the various movements of the body. According to Hertwig and Lesser's amended description, the *Plagiophryses* are monothalamic Thalamophora with definite and but slightly varying body-forms and with branched filiform pseudopodia which seldom or never anastomose. They have a delicate test, which lies close upon the body, participates in the slight changes of shape of the included protoplasm by becoming thrown into folds, and is provided with a single orifice for the passage of the pseudopodia. Two new species are described.

Hertwig and Lesser* have raised the *Arcella hyalina* of Ehrenberg into a new genus under the name of *Lecythium*. This rhizopod has been further examined by Cienkowski †.

Its nearly spherical membranous shell is of a crystal clearness, and is closely applied to the protoplasm. The pseudopodial orifice, which is borne by a very short neck, is situated a little to one side, so that the shell possesses a slightly bilateral symmetry. The protoplasm presents a posterior almost perfectly homogeneous division in which is imbedded the large spherical nucleus with its nucleolus, and an anterior granular division rich in vacuoles, which show no pulsation. It is especially distinguished by its greatly developed pseudopodia-emitting mass of protoplasm (*Pseudopodienplatte*) which pours itself out of the shell-orifice in order to send forth strong radiating and rarely anastomosing pseudopodia, and which either forms an amorphous mass or envelopes the entire body with a pseudopodial mantle.

Lecythium usually forms colonies in grape-like clusters with a common pseudopodial plate; the colonies result from a longitudinal division of the rhizopod.

Nearly allied to *Lecythium* is a monothalamic rhizopod to which Cienkowski gives the name *Chlamydophrys stercorea*, and which he frequently met with during his researches among fungi

* "Ueber Rhizopoden," &c. Arch. f. mikr. Anat. Band x. Supplement-Heft.

† "Ueber einige Rhizopoden und verwandte Organismen," Arch. f. mikr. Anat. 1875.

which inhabit the excreta of animals. He regards it as identical with the *Difflugia enchelys* of Schneider. It has a clear glassy shell destitute of sculpture.

Its reproduction takes place by the protrusion from the shell-orifice of a mass of protoplasm in which a nucleus makes its appearance independently of that of the parent. The protruded protoplasm soon becomes invested by a delicate shell, and the whole might now be easily mistaken for two individuals in conjugation. At the same time pseudopodia radiate from the common bridge of protoplasm, and finally the two parts separate from one another.

But *Chlamydophrys* is, like *Lecythium*, a colony-forming rhizopod; and in this case the zooids formed by successive constrictions of the protruded protoplasm remain united to one another so as to form the grape-like clusters with the shell-openings directed towards the common point of union originally observed by Schneider.

Cienkowski frequently found individuals with two, three, or more nuclei. A similar multinucleate condition occurs in *Arcella*, *Actinosphæria*, and *Nuclearia*. The real significance of this character, which has an obvious bearing on the unicellular theory of the Protozoa, is not very evident. It is possibly, as suggested by Cienkowski, the beginning of a zoospore-formation or of fission.

To the development-cycle of *Chlamydophrys* belongs also a resting-state which, as in other cases, appears to be conditioned by the drying up of the locality. When passing into the resting-state, the entire body escapes from the shell, assumes a spherical shape, and clothes itself with a thick membrane. In the grape-like clusters the resting-state is introduced by all the members of the colony with their common protoplasmic basis becoming fused together and enveloped in a single cyst.

In the same group of single-chambered Thalamophora is an elegant little rhizopod to which Archer, who first described it, gives the name of *Gromia socialis*, and which possesses, like *Lecythium* and *Chlamydophrys*, the curious habit of becoming united with neighbouring individuals into a common colony by the mutual fusion of the pseudopodia.

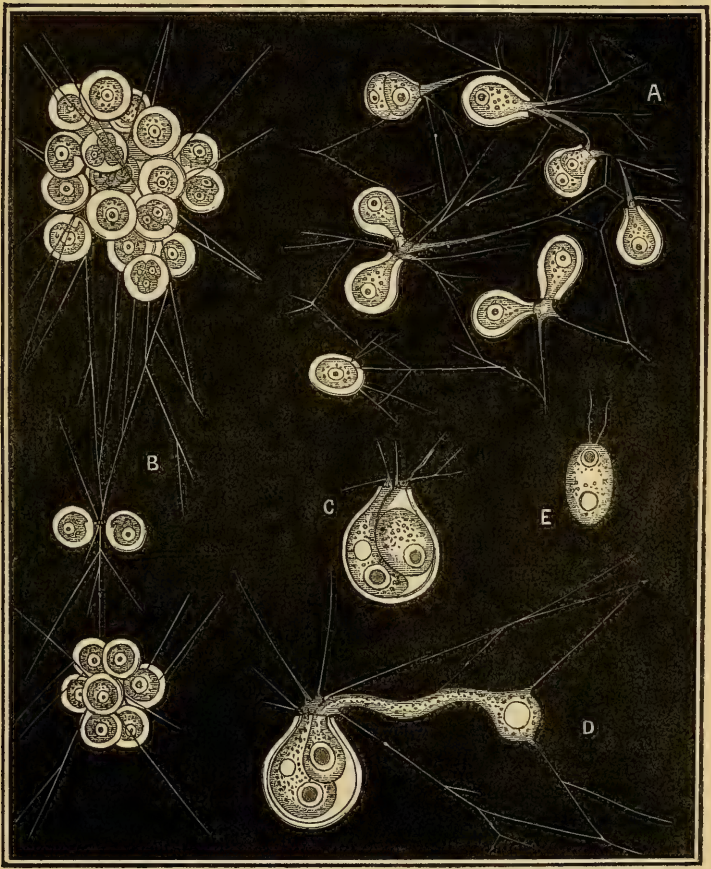
Archer's *G. socialis* has been further investigated by Hertwig, who has raised it into a new genus under the name of *Microgromia**.

In a highly interesting and important memoir he has given us

* "Ueber Microgromia," Schultze's Archiv, Band x. Supplement-Heft.

the results of a careful study of this remarkable little rhizopod (fig. 6). The nearly globular shell is prolonged into a short neck, which carries the pseudopodial orifice. It thus allows an oral and aboral pole to be distinguished, while the orifice being a little to one side gives to the shell a slightly bilateral symmetry.

Fig. 6.



Microgromia socialis.

A, a colony in its extended state; some of the individuals seen in longitudinal fission. B, a colony in its compact or cystophrys state; some of the individuals at a distance from the main heap. C, formation of a swarm-spore; the portion which is to become a swarm-spore has advanced towards the anterior end of the shell. D, further stage in the formation of a swarm-spore; the portion which is to become a swarm-spore escaping through the orifice of the shell. E, one of the swarm-spores now complete and free. (After Hertwig.)

The protoplasm passes outwards through the neck, and expands fungus-like over the margin, where it attaches the body to the shell. From this fungus-like expansion the pseudopodia radiate in all directions.

The body consists of a pale bluish protoplasm with its anterior half granular and its posterior half almost perfectly homogeneous. In the posterior is imbedded the nucleus. This possesses the form common to the nuclei of almost all the freshwater Rhizopoda —that of a clear, perfectly colourless, spherical body containing concentrically within it a spherical pale-bluish nucleolus. The membranous investment which, in some Rhizopods, surrounds the nucleus is here wanting. In the anterior granular portion of the protoplasm lies the contractile vacuole.

Hertwig and Lesser find the individuals not only united by their pseudopodia into the loose colonies described by Archer (fig. 6, A), but also, by a close union, constituting botrylliform clusters (B). He regards these botrylliform clusters as identical with a form described by Archer as an independent organism under the name of *Cystophrys Haeckeliana*, which is thus, according to Hertwig, nothing more than a heap of *Microgromia socialis*.

Hertwig has further found that *M. socialis* multiplies itself by means of locomotive germs, a discovery of importance in its bearing on the development-history of the Monothalamia. He has seen the protoplasm of the various members of the colony divide by a transverse constriction into two halves, each with its nucleus and its contractile vacuole. The posterior segment remains for some time free in the bottom of the shell and then presses forward (C), and, by means of amœboid movements, escapes through the pseudopodial orifice (D). After its escape from the shell the amœboid movements continue, and the germ now stretches itself out into the form of a worm, or contracts into a globe, or forms a lobed mass of protoplasm spreading over the pseudopodia of the mother colony. It then gathers itself together, acquires an oval form, develops from one end a pair of flagella, and forsakes the colony as a free-swimming swarm-spore (E); or, in other cases, instead of becoming a flagellate swarm-spore, assumes an *Actinophrys*-like form and moves about by the aid of three or four more or less branched pointed pseudopodia. Hertwig was not able to trace them to their ultimate destiny; but there can be little doubt that both kinds of locomotive germs come, after a time, to rest, excrete a shell, and lay the foundations of new colonies.

The observations of Hertwig render it probable that the simple extension of the colony without separation of the newly formed zooids takes place by a longitudinal instead of a transverse division of the body. Two or, in some cases, three segments are thus formed. Of these, one remains in the old shell, the others forsake it and excrete for themselves a new one, while all continue in union by their common pseudopodial end.

Cienkowski * has, in all important points, confirmed these observations. He finds further that the second cell-nucleus which appears during the division of the shell-contents arises independently, and not by the division of the mother nucleus.

Among the genera of Thalamophora in which the shell possesses a definite structure, *Euglypha* (fig. 7) may be regarded as the most typical. This genus was founded by Dujardin, and Hertwig and Lesser retain in its essential points the definition given by the French observer. The *Euglyphæ* are Rhizopoda with pointed filiform pseudopodia which show no granule-currents, and do not anastomose with one another, but for the most part ramify dichotomously. The oval or flask-shaped shell is a pure secretion from the surface of the protoplasm, and remains unchanged under the action of concentrated mineral acids and of alkalies. The terminal orifice is, for the most part, finely dentate, and the solid and inflexible walls of the shell have a sculpture which, as was first pointed out by Carter and by Wallich, is caused by spirally disposed plates which, in all the forms examined by Hertwig and Lesser, are hexagonal and in contact by their edges.

In the protoplasm may be distinguished an anterior and a posterior region. The former occupies nearly two thirds of the whole. The protoplasm of the anterior region is finely granular; it alone contains the foreign matter ingested for nutriment. The protoplasm of the posterior third is homogeneous, but frequently contains some darkly coloured granules of nearly uniform size. In all cases it contains the cell-nucleus first observed by Carter. This has the form so well known in the nucleus of the Rhizopoda, that of a roundish or oval vesicle with a central homogeneous pale blue oval nucleolus. Included in the protoplasm, at the boundary between the anterior and posterior regions, are the contractile vacuoles, generally two or three in number.

F. E. Schulze has studied these vacuoles in *Euglypha alveolata*,

* "Ueber einige Rhizopoden und verwandte Organismen," Arch. für mikr. Anat. 1875.

Dujardin (fig. 7), one of the finest of the freshwater Monothalamia, and has determined the time which intervenes between each systole. He has found that, at a temperature of 16° Réaumur, this was almost exactly 90 seconds. The pulsation was of that kind which is general among the Rhizopoda, a rapid contraction followed by a gradual accumulation of a clear liquid in the same place until the vacuole becomes once more completely filled, then another sudden collapse, and so on.

Hertwig and Lesser have made some further interesting observations on *Euglypha alveolata*. They have observed in it the structures which Carter calls "granuliferous cells," and which he believes to be produced by the division of the nucleolus, and to be connected with the formation of spermatozoids. Hertwig and Lesser, however, have been unable to assert any thing regarding the economy of these "granuliferous cells." They are roundish vesicle-like bodies irregularly scattered through the protoplasm outside of the nucleus, and more or less filled with small round bluish granules, which mostly appear arranged in regular concentric circles. They show a great resistance to concentrated acetic acid, a fact which is scarcely consistent with their derivation from the nucleolus; and when present they are usually in considerable number, without either the nucleus or the nucleolus having disappeared.

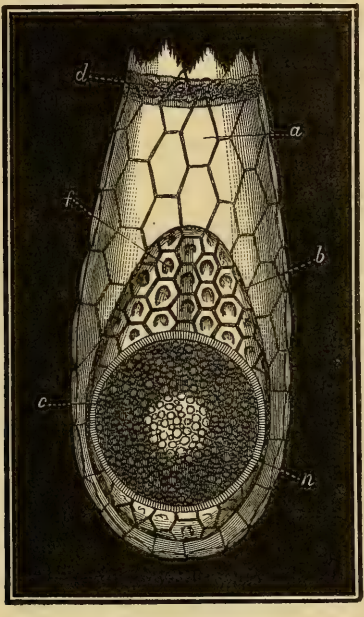
Euglypha alveolata is remarkable for the rich development of its pseudopodia, and for the frequency of their subdivision. They mostly spring from broad-lobed homogeneous processes of the protoplasm.

Within the shell of *Euglypha alveolata* may often be seen detached plates resembling in size and form those of the shell itself. They have been noticed by different observers, but more especially by Hertwig and Lesser and by F. E. Schulze. In individuals in which the living protoplasm is still included, they lie upon its surface in a layer parallel to the shell-walls. They are probably destined for the building up of a new shell after the shedding of the old one, or, as Hertwig and Lesser suggest, may be connected with the formation of the inner shell in the peculiar encysting process which they have studied in this rhizopod. Similar plates have also been found by Hertwig and Lesser in the *E. ampulacea*, Dujardin.

The encysting process (fig. 7) which Hertwig and Lesser have studied in *E. alveolata*, and which had been previously noticed by

Carter, is very remarkable. Its peculiarity consists in the fact that the cyst is not immediately surrounded by the outer shell of the rhizopod, but by a second shell which lies within this and is

Fig. 7.



Euglypha alveolata.

Encystation with the formation of a double cyst-covering.

a, the colourless shell formed of hexagonal plates and closed at *d* by agglutinated foreign bodies; *b*, the outer brown egg-shaped cyst-shell; *c*, the inner spherical colourless cyst-shell; *f*, the homogeneous colourless cord which extends through the space between the inner and outer cyst-shell; *n*, the clear inner portion of the contents of the cyst, apparently corresponding to a nucleus. (After Hertwig and Lesser.)

completely closed. This inner shell is oviform, with the narrow end turned towards the pseudopodial orifice of the outer shell, within which it lies free and movable. Its structure resembles that of the outer shell; but it is of a light brown colour, which is intensified by the application of sulphuric acid and iodine, while these reagents cause no change in the colour of the outer shell.

Within the inner shell lies the proper cyst. This is of a

spherical form; and in all the specimens examined its contents consist of minute granules which by their strong refringency render the whole dark and opaque, and make an exact knowledge of the contents of the cyst impossible, though a lighter central portion, probably a nucleus, can be distinguished from a darker cortical portion. The cyst consists of a nitrogenous membrane, and has a finely punctured structure; it is connected with the narrow end of its closed investing shell by a thin solid homogeneous cord. The formation of the cyst and its investing shell is accompanied by the closure of the outer shell-orifice by a temporary plug formed by foreign bodies, such as filaments of Algæ and shells of Diatoms.

Hertwig and Lesser regard all this as nothing more than an example of the encysting process so widely distributed among the Rhizopoda, and whose original object consisted most probably in protection against the evil consequences of the drying up of the surrounding water, but which in many cases has become further subservient to a multiplication by self-division of the protoplasm.

The genus *Cyphoderia* was founded by Schumberger for a beautiful little monothalamian rhizopod which he obtained from fresh water in the Vosges and in the Jura, and described under the name of *C. margaritacea*. This is the same rhizopod which Max Schultze found in the Baltic, and to which he assigned the name of *Lagynis baltica*. It has been most recently studied by Hertwig and Lesser and by F. E. Schulze. It is remarkable for the elegant form of its shell, which, instead of being oval, as in *Euglypha*, has its anterior end produced into a short curved neck so as to give to the shell somewhat the form of a retort. The shell-structure resembles that of *Euglypha* except in the smallness of its component plates and the absence of distinct serration at the orifice. The contractile vacuoles are in the anterior region of the protoplasm, instead of lying, as in *Euglypha*, on an equatorial plane between the anterior and posterior.

F. E. Schulze has obtained this rhizopod from very different localities, and from both fresh, salt, and brackish water. He finds the posterior part of the shell often containing only water, through which bands of protoplasm pass from the soft body to the shell-walls. In the midst of the thick posterior part of the body is always a large, clear, spherical nucleus in which one or more dark roundish nucleoli can be demonstrated. The pseudopodia are destitute of granules, divide at acute angles, run out into fine

points, and seldom anastomose. He describes a narrow membranous margin surrounding the orifice and overlooked by other observers.

Among specimens obtained from the Baltic, Schulze has occasionally met with two individuals united to one another by the pseudopodial extremities; but he has not followed this phenomenon further.

Under the name of *Cyphoderia truncata* Schulze has described a species in which the main axis is not curved, and has the shell-orifice transverse to it; but it is difficult to see how such a form can be referred to the genus *Cyphoderia*.

The genus *Pleurophrys* was founded by Claparède and Lachmann for a freshwater monothalamian rhizopod which resembles *Difflugia* in the fact of its test being composed of foreign particles united by a cement excreted from the surface, while it differs from this genus in its pseudopodia being filiform and pointed instead of being finger-shaped and blunt. The *P. sphærica,* Clap. & Lach., has been further studied by Archer and by Hertwig and Lesser and F. E. Schulze, all of whom have described new species. It appears to be an abundant form, though it has been rarely noticed, a fact which Archer explains by calling attention to the peculiar appearance of its test, which resembles the excreta of Rotifers and other microscopic animals, and which would thus easily cause it to be overlooked. The foreign particles incorporated in its test resist the action of concentrated acids, and are probably siliceous.

The pseudopodia issue from a rather large roundish orifice situated on one end of the longer axis. They are hyaline, very fine, and pointed, divide frequently at acute angles, and anastomose with one another. Hertwig and Lesser differ from Archer in describing them as enclosing granules. Archer has demonstrated the presence of a nucleus.

Archer has noticed in *Pleurophrys amphitrematoides*, Arch., the presence of chlorophyl granules, a fact also observed in *Difflugia*, but not elsewhere met with among the freshwater Thalamophora. In examples of *P. amphitrematoides,* however, examined by F. E. Schulze, this observer has found the chlorophyl granules replaced by round colourless refringent granules quite like them except in the absence of colour.

Hertwig and Lesser have frequently met with two individuals in apposition by their pseudopodial openings, and with the pseu-

dopodia of one confluent with those of the other. Archer has noticed a similar conjugation in another species, with streams of the granular protoplasm passing to and fro from one into the other.

Diaphoropodon mobile, Archer, which is one of the largest of the encased freshwater Rhizopoda, has a rude test formed of heterogeneous foreign particles loosely aggregated round its elliptical body. From an aperture in one end of the test the sarcode mass protrudes in the form of a hemispherical projection, and from this are emitted numerous hyaline branching pseudopodia, which frequently attain an enormous length. But the most singular character of the genus is found in the fact that from the whole of the included surface of the sarcode body are emitted very numerous, short, simple, hyaline pseudopodia which traverse the outer case, giving to its surface the appearance of a dense flocculent clothing. The animal is further remarkable in the possession of a marginal pulsatile vesicle like that of *Actinophrys*. A large globular nucleus is immersed in the body.

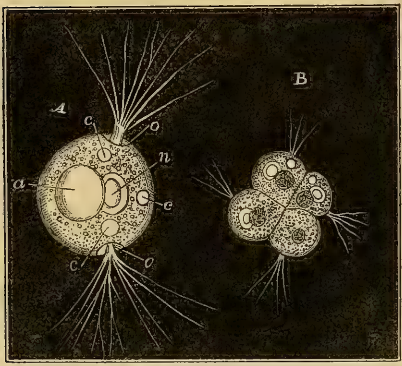
In none of the Monothalamia now described have more than one definite orifice been detected. In *Diaphoropodon* alone, besides the definite single orifice, there would appear to exist in the membranous basis of the test a vast multitude of minute pores through which delicate pseudopodial filaments are emitted, and which call to mind the condition of the true Perforata. All these constitute the *Monothalamia monostomata* of Hertwig and Lesser. There exist, however, forms in which two definite pseudopodial orifices are present; these are the *M. amphistomata* of the same authors.

One of these has been recorded by Barker* under the name of *Diplophrys Archeri* (fig. 8), and has more recently been made the subject of some very interesting observations by Hertwig and Lesser†. It has a simple elliptical membranous test and, notwithstanding its minuteness, is rendered conspicuous by a bright yellow fat-globule enclosed in its sarcode. The two orifices from which the brushes of pseudopodia radiate are nearly, but not exactly, at opposite ends of the longer diameter of its oval test. Each brush springs from the extremity of a short stem-like process of the sarcode. The conspicuous large yellow globule in the interior consists apparently of a solid fatty matter. Near to this is a nucleus

* Quart. Journ. Micr. Sci. vol. xvi.

† "Ueber Rhizopoden" &c., Arch. f. mikr. Anat. vol. x.

Fig. 8.



Diplophrys Archeri.

A, lateral view: *a*, brilliant yellow fatty body; *c*, *c*, *c*, contractile vacuoles; *n*, nucleus; *o*, *o*, the two opposite pseudopodial orifices. B, a group composed of four segments showing the mode in which the so-called cystophrys-heaps are formed. (After Hertwig and Lesser.)

with its nucleolus, while several contractile vacuoles are distributed through the sarcode.

The observations of Hertwig and Lesser have led them to the conclusion that the *Diplophrys* is multiplied by a process of continuous binary fission, the resulting brood remaining for some time united to one another in little heaps (fig. 8, B). They think that the individuals which thus become divided are destitute of shells. They have further convinced themselves that what Archer describes as an independent organism under the name of "*Cystophrys oculea*" is nothing more than one of these heaps of young *Diplophrys*, whilst they also show that Greeff was equally in error when he supposed that the *Diplophrys* was a development stage of the heliozoan *Acanthocystis spinifera*.

On fresh horsedung kept under a bell-glass in summer Cienkowski has seen minute yellow globules of the size and appearance of a mucor sporangium. When these little globules are touched under the microscope, they may be seen to break up into a multitude of oval or lenticular corpuscles, which scatter themselves over the field. These are cells containing a nucleus, one or two contractile vesicles, and a yellow pigment-globule. We may perceive in them a slight jerking motion, while on each end one or two long pseudopodia have become apparent. After a time the cells become united to one another in chains by their

pseudopodia, or are aggregated in heaps. The chains of cells remind us strongly of the *Labyrinthulea.* They move about, creep over the surfaces, and finally unite into the little yellow globules in which they were first noticed.

Cienkowski places this curious little organism in the genus *Diplophrys*; though, from its minuteness, it is not easy to say whether it is naked or furnished with a shell. He assigns to it the specific name of *stercorea.*

The only form of multiplication observed in it is by fission, as in *Diplophrys Archeri.* During the fission the yellow pigment-globule in its interior participates in the division.

Another amphistomatous freshwater rhizopod nearly allied to *Diplophrys*, from which it differs mainly in its elliptical test being strengthened by the incorporation of foreign particles, is Archer's genus *Amphitrema* *. At each end of the longer diameter of the test is a round orifice through which is emitted a dense tuft of branching pseudopodia.

Among the most important results derived from recent study of the Rhizopoda is the discovery of a nucleus in the so-called Foraminifera. The failure of all previous attempts to demonstrate the presence of a nucleus in the calcareous-shelled marine Rhizopoda, whether monothalamian or polythalamian, led to the belief that they possessed the morphological value of a cytode or non-nucleated protoplasm mass, and they were accordingly relegated to the lowest stage in the systematic arrangement of the Rhizopoda.

This view must now be abandoned; for the independent and nearly simultaneous researches of Hertwig † and of Franz Eilhard Schulze ‡ have demonstrated the presence of a nucleus in representatives of all the principal divisions of the Foraminifera, and justify us in the general conclusion that their protoplasm is in every case nucleated.

By the aid of dilute chromic acid and subsequent tinging with carmine, Hertwig succeeded in demonstrating a nucleus in young specimens of *Miliola,* which as yet consisted of but a single chamber, as well as in older ones where additional chambers had been formed. In the latter case the number of the nuclei was

* Archer, *loc. cit.*

† Jenaische Zeitsch. vol. x. (1876).

‡ Arch. f. mikr. Anat. vol. xiii. (1876).

also generally increased, but not necessarily in the same ratio as that of the chambers. In some of the chambers there occurred only one nucleus, while others contained several.

The nucleus appears to enclose a nucleolus and to be invested by a membrane, thus corresponding in its structure with that of the freshwater Monothalamian Rhizopods.

Similar results followed the employment of the same method of investigation in *Rotalia* and in *Textillaria*, in both of which genera Hertwig succeeded in demonstrating the presence of nuclei.

Schulze had already seen what he regarded as a nucleus with nucleolus in one of the Foraminifera, *Quinqueloculina fusca*, Brady*; and he now finds an undoubted nucleus lying near the posterior end of the shell in *Entosolenia globosa*, one of the marine monothalamian rhizopods belonging to the family of the Lagenidæ.

In the very abundant polythalamian rhizopod *Polystomella striatopunctata* he has also demonstrated the presence of a nucleus, and has carefully followed out its relations.

The nucleus here has a manifest thick outer membrane with clear contents in which were several strongly refringent roundish bodies. Usually only one such nucleus was to be found in each *Polystomella*, and then always near the middle of the series of chambers; but occasionally two or three occurred each in a separate chamber.

From the dependence of the position of the nucleus on the entire number of the chambers, it is obvious that it must be continually migrating from one chamber to another through the canals of communication. Indeed the nucleus may frequently be seen still engaged in one of the canals between two neighbouring chambers, so as to be partly in one and partly in the other.

From the fact of the many-chambered *Polystomella* containing, as a rule, only one nucleus, we should be justified in assigning to it the morphological value of a single cell; and even in those cases in which in this and other Foraminifera several nuclei have been seen, this multinucleate condition cannot be regarded as indicating a multicellular structure of the organism. It is probably connected with reproduction; and an observation of Hertwig on *Rotalia* contributes some additional facts to our knowledge of the reproduction of the Foraminifera, hitherto observed in but very few instances.

* Arch. f. mikr. Anat. vol. xi.

Hertwig noticed on the walls of the jars containing living specimens of *Rotalia* little heaps of from twenty to forty small 3-chambered individuals which were united to one another by their protoplasm, and in each of which he succeeded in demonstrating a single nucleus. Max Schultze had shown that in some other genera the young are not only developed within the shell of the maternal animal, but become invested with their own shell before leaving the parent; and it is highly probable that these little colonies of young *Rotalia* have a similar origin.

From what is thus known of the reproduction of the Foraminifera, we may conclude that the protoplasmic body of the parent breaks up into segments, conditioned by the nuclei which had been developed in it, while each of these segments forms for itself within the maternal shell its own investment. In *Rotalia* they would seem to become free by the destruction of the parent shell and then to live for a time in union with one another.

The discovery of a nucleus in the Foraminifera will now determine the place which we must assign to them among sarcode organisms; and F. E. Schulze has accordingly attempted by means of a hypothetical genealogical tree to express the descent and mutual affinity of all the leading groups of the Rhizopoda. He employs this designation in a wider sense than has been accepted by many recent zoologists, and embraces under it all those low organisms which, during the greater part of their lives, and especially during the period of their highest development, are brought into relation with the external world by means of pseudopodia, which they employ for locomotion and for the prehension of nutriment. All these organisms agree essentially with one another and constitute a definite group, whether a nucleus be differentiated or not, whether pulsatile vacuoles or hard parts be present or absent, or whether the pseudopodia present the condition of broad lobes, of fine filaments, of a complex network, or of any other modification.

The base of the tree where its stem is as yet undivided consists of the primitive forms—mere non-nucleated cytodes—represented by Haeckel's *Monera* (*Protamœba*, *Protogenes*, *Protomyxa*, *Myxodictium*, &c.). From these, by the differentiation of a nucleus in their protoplasm, are evolved the nucleated forms (*Amœba*, freshwater *Monothalamia*, *Foraminifera*, *Heliozoa*, &c.) which constitute the subdivisions into which the stem branches off. These repeat the various modifications of pseudopodia (lobose,

filiform, &c.) which had already existed in the earlier forms, and which they thus derive by inheritance from their non-nucleated progenitors. Finally, through the branch of the *Heliozoa* we are conducted to the ultimate twigs formed by the families of the *Radiolaria*, in which we find not only nuclei, but a "central capsule," indicating the highest grade of differentiation attained by any members of the group.

In 1863 Cienkowski published the results of a series of careful observations on the development of the *Myxomycetæ**, a group of very low organisms which had been unhesitatingly assigned to the fungi, until De Bary had a few years previously called attention to their real nature, and in a very important memoir † pointed out the predominance in them of characters which had been generally regarded as the proper attribute of animals. De Bary believed that the facts which he had demonstrated in the structure and life-history of the *Myxomycetæ* would render necessary their removal from the vegetable and their relegation to the animal kingdom.

Shortly after the appearance of De Bary's memoir, some further important observations on the *Myxomycetæ* had been made by Currey‡, who fully confirmed the production by them of free locomotive bodies resembling the zoospores of an Alga.

The researches of De Bary, of Currey, and of Cienkowski have now made us well acquainted with the structure and development of these extraordinary organisms. A typical Myxomycete (fig. 9) consists of a network of ramifying and anastomosing threads of a slimy or creamy consistence, which spreads over the surface of decayed leaves and stems (A).

From various parts of this slimy network there arise oval vesicles (sporangia) (B) with membranous walls, within which the reproductive bodies or spores are developed.

De Bary was the first to show that the basal network is composed of a substance possessing all the characters of animal sarcode, and his observations have been fully confirmed and further extended by subsequent observers, more especially by Cienkowski. Under the microscope the threads composing the network exhibit active spontaneous movements, which in the larger branches are visible under an ordinary lens or even by the naked eye. A

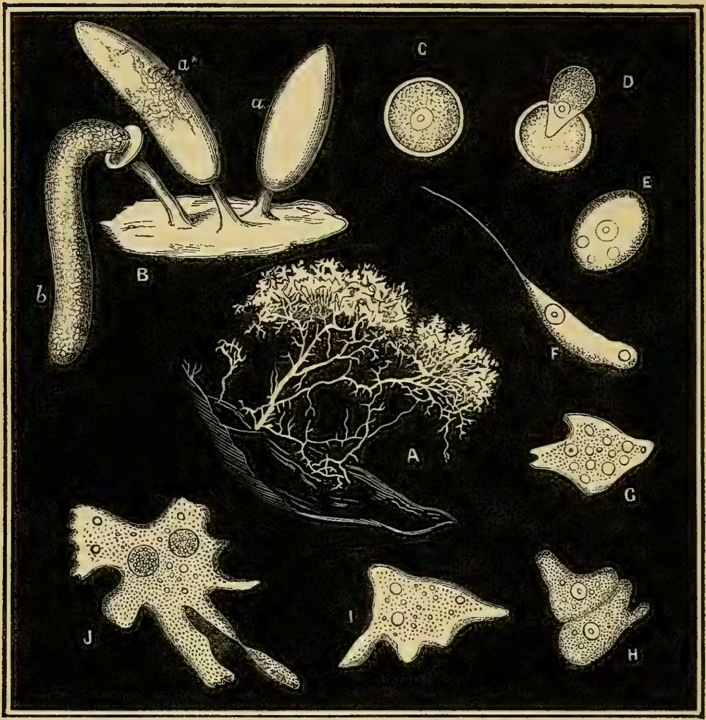
* "Zur Entwickelungsgeschichte der Myxomyceten," Prings. Jahrb. 1863.

† "Die Mycetozoen," Zeitschr. f. w. Zool. 1860, vol. x.

‡ Natural History Review, No. viii., Oct. 1862.

succession of undulations may be then noticed passing along the course of the threads; and under higher magnifying-powers the characteristic sarcode currents show themselves in constant streams of granules flowing along the threads and streaming from branch to branch of this wonderful network. Here and there

Fig. 9.



Development of the *Myxomycetæ*.

A, the plasmodium of *Didymium serpula* (natural size). B, sporosacs of *Arcyria flava*: *a*, young sporosac; *a**, sporosac in the act of bursting; *b*, capillitium exposed after the bursting of the sporosac and the diffusion of the spores. C, ripe spore of *Physarum album*. D, the same, with its contents escaping. E, the contents become free, and showing nucleus and contractile vacuoles. F, the same, after having developed a flagellum and assumed the condition of a swarm-spore. G, the swarm-spore become Amœboid. H, two Amœboid swarm-spores in close juxtaposition. I, the two *Amœbæ* fused together into a young plasmodium. J, the plasmodium more advanced; it has already begun to ramify and to take in nutriment: two nutriment-pellets are seen imbedded in its protoplasm. (After Greville and Cienkowski.)

sarcode offshoots are projected and again withdrawn in the manner of the pseudopodia of an *Amœba*, while the whole organism has been occasionally seen to abandon the support over which it had grown, and to creep over neighbouring surfaces, thus far resembling in all respects a colossal ramified *Amœba*.

From the surface of this sarcode-net there arise, as has just been said, the reproductive capsules or sporangia. In the soft plasma with which these are filled appear a multitude of nuclei, and the plasma then divides into a great number of roundish masses, in each of which a nucleus is enclosed. These are the young spores; they are accompanied in most species by a fibrous network, the "capillitium" (fig. 9, B, *b*), which fills up the intervals between the spores. When mature the sporangium bursts and allows the spores to escape (C). These are each enclosed in a thick membrane, which, after a time, becomes ruptured, and the little soft round mass of protoplasm which it had confined is set at liberty (D).

This little protoplasm lump encloses a nucleus with a minute central nucleolus, and contains one or two pulsating vacuoles (E); and soon after its escape it begins to show spontaneous movements, and to exhibit constant changes of form, while one end is drawn out into a long vibratile flagellum, by means of which, when placed in a drop of water under the microscope, it may be seen swimming about in the manner of the swarm-spore of an Alga (F). After a time it may be observed to withdraw its flagellum, emit and retract pseudopodia, and creep about like an *Amœba* over the stage of the microscope (G). It now takes in foreign bodies as nutriment, enveloping them in its substance; it multiplies by self-division, and in all respects conducts itself like a genuine *Amœba*.

In the next place, a certain number of these amœbiform bodies approach one another, come into close contact (H), and ultimately become completely fused together into a common mass of protoplasm (I). To the body thus formed by the fusion of the *Amœbæ*, Cienkowski has given the name of "plasmodium."

The plasmodium continues, like the simple amœbiform bodies of which it is composed, to grow by the ingestion of solid nutriment which it envelopes in its substance (J); it throws out ramifying and inosculating processes, and finally becomes converted into a protoplasmic network, which, in its turn, gives rise to sporangia with their contained spores, and thus completes the cycle of its development.

Under certain conditions not yet perfectly understood the

Myxomycetæ have been observed to pass from an active motile state into a resting state; and this may occur in both swarm-spores and plasmodium. In the case of the swarm-spores, these bodies, when passing into the resting state, assume a spherical form, and become surrounded by a delicate membrane or by a firm external layer of thin protoplasm. In this condition, in which they constitute the "microcysts" of Cienkowski, they may remain, after complete desiccation, in a dormant state for more than two months; and on being again placed in water they soon resume their original activity.

But the plasmodium itself, as well as the swarm-spore, may pass into a resting state. After withdrawing its finer branches, and expelling such solid ingesta as may be included in it, its motions gradually cease, it breaks up into a multitude of polyhedral cells, and the whole body dries into a horny brittle mass, to which the term "sclerotium" has been given.

It sometimes happens that the plasmodium, instead of forming a continuous sclerotium, breaks up into separate pieces of very unequal size, which withdraw their projecting branches and assume the form of smooth spheres, round which a thick membrane is excreted. Within this outer membrane the protoplasm contracts and forms on its surface a second membrane. To these cell-like bodies Cienkowski has given the name of "thick-walled cysts."

Both these resting states of the plasmodium may, like that of the swarm-spores, undergo complete desiccation, and thus continue for many months in an inactive state without losing their vitality. When the dry sclerotium is placed in water, it immediately swells up, and after a time its cells again flow together into an amœboid protoplasm. So also when the thick-walled cysts, after remaining long desiccated, are similarly treated, their membrane will become ruptured, and the contained protoplasm will escape and begin to throw out pseudopodia and glide about like an *Amœba*, and engulf within its substance foreign bodies for nutriment, while several may unite by fusion into larger amœbiform masses and thus give rise in their turn to new plasmodia.

In a subsequent paper* Cienkowski describes the plasmodium of an unknown Myxomycete which occurs in fresh water in the form of a sarcode network, and which has enabled him to add some interesting facts to our knowledge of the plasmodium.

* Cienkowski, "Ueber einige Rhizopoden und verwandte Organismen," Archiv f. mikr. Anat. 1875.

He found that a fragment broken off from this plasmodial network moves about independently, and he saw it throw out a long pointed pseudopodium which attached itself to an Alga, penetrated its walls and sucked out its contents in the manner of a *Vampyrella*, another simple sarcode organism to which we shall presently refer.

Whether the *Myxomycetæ* should take their place in the animal or vegetable kingdom is a question which in the present state of our knowledge it is impossible to answer. Haeckel has evaded the difficulty by placing them, along with a number of other doubtful organisms, in his kingdom of the *Protista*, which he regards as holding an intermediate place between animals and plants.

Cienkowski has followed his researches on the *Myxomycetæ* by another important memoir on a group of minute sarcode organisms to which he has assigned the name of *Monadinæ**. During certain phases of their development they resemble in many respects the well-known zoospores of the Algæ, and might, indeed, be so regarded, were it not that, like the swarm-spores of the *Myxomycetæ*, they have been proved to pass through a special and peculiar cycle of development which entitles them to be viewed as an independent group.

Cienkowski has given us the life-history of five forms which he refers to his *Monadinæ*. Two or three of them may be here adduced with the view of giving an adequate conception of these remarkable organisms.

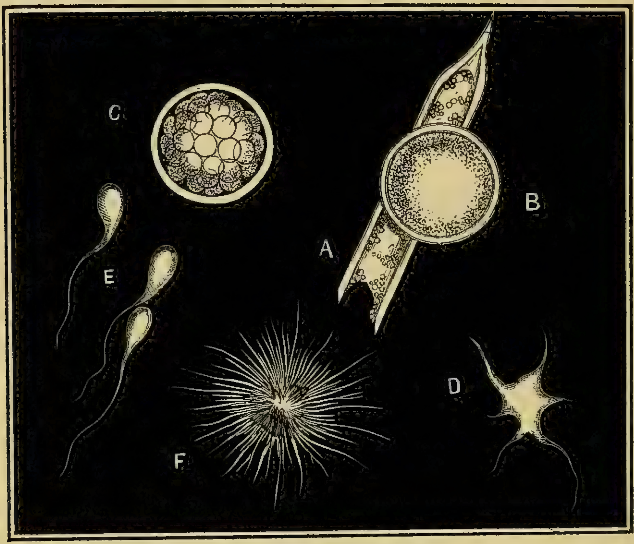
In the cells of decaying *Nitella* there may be found certain minute spindle-shaped very contractile bodies, which move about by the aid of cilia, and which closely resemble the swarm-spores of the *Myxomycetæ* or of the Algæ. Cienkowski has assigned to them the name of *Monas amyli*. After a time they lose their cilia, emit pseudopodia, and, assuming the form of an *Amœba*, creep about and take in foreign matter as nutriment by enveloping it in their soft protoplasm. Further, two or more of these amœbiform bodies may unite and become fused together into a plasmodium like that of the *Myxomycetæ*.

After enjoying for a time its free locomotive condition, *Monas amyli* passes into a resting state. The amœbiform body begins to harden itself on its surface into a continuous membrane, and thus becomes enclosed in a capsular covering. After continuing thus

* Cienkowski, "Beiträge zur Kenntniss der Monaden," Arch. f. mikros. Anat. 1865.

encysted for a certain time, the contents of the capsule become broken up into numerous separate masses of protoplasm, which finally escape in the form of the spindle-shaped zoospores found in the *Nitella*.

Fig. 10.



Protomonas Huxleyi.

A, fragment of a cylindrical diatom (*Rhizosolenia*) to which the *Protomonas*, B, in its encysted state, is attached. C, the cyst with its contents broken up into spherical non-nucleated protoplasm masses. E, the spherical masses, after having developed a flagellum, have become free swarm-spores by the rupture of the cyst. D, amœboid condition assumed by the swarm-spore. F, the amœboid swarm-spore having assumed the form of an *Actinophrys* by the emission of numerous fine pseudopodia. (After Haeckel.)

The generic name of *Monas*, under which Cienkowski has described this singular organism, has been changed by Haeckel * into that of *Protomonas*, on the very tenable ground that the name of *Monas* had been long applied to a group of microscopic organisms which we should not be justified in confounding with the monads of Cienkowski. Haeckel has, moreover, described another representative of the genus, which he found in the Canary Islands attached to the surface of a floating diatom, and which he names *Protomonas Huxleyi*. He gives a very complete account of its life-history, which is in all essential points like that of *P. amyli*.

* Monographie der Moneren.

I have taken Haeckel's figures (fig. 10) as affording an excellent illustration of the life-history of this remarkable group of organisms*.

A still more remarkable genus of *Monadinæ* is *Vampyrella*, Cienkowski. Perhaps the most interesting of the three species of *Vampyrella* described by Cienkowski is the *V. spirogyræ* (fig. 11). This has long been known to algologists in the form of spherical brick-red capsules (B), which are often found attached to the filaments of the confervoid alga *Spirogyra*. It is, however, the merit of Cienkowski to have discovered the real nature of these capsules and to have satisfactorily traced their life-history.

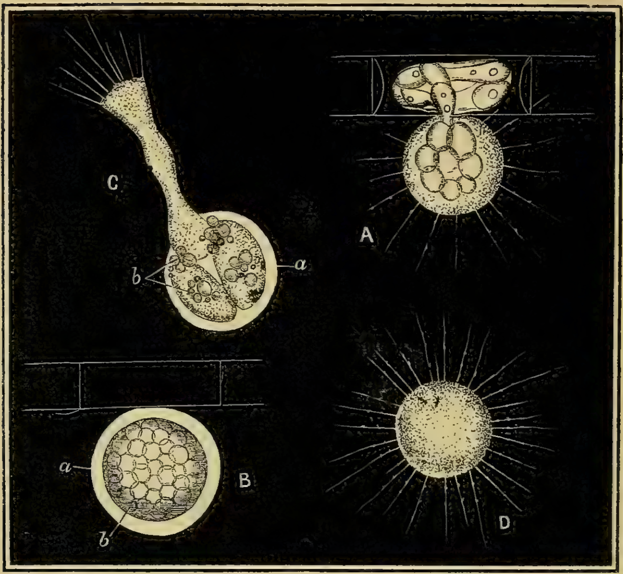
The walls of the capsule are composed of two membranes. The inner gives the characteristic cellulose reaction, becoming blue when treated with sulphuric acid and iodine. The outer membrane, which in the older capsules is often absent, forms a soft nitrogenous layer. The contents of the capsule consist of a brick-red protoplasm with, usually, large dark irregular granules towards the centre caused by foreign matter which had been taken in as nutriment. By carefully continued observations the contents may be seen to divide into two or four portions (tetraspores) (C), and then to escape in the form of red *Amœba*-like bodies through round openings in different parts of the capsule. The dark bodies which remain behind in the capsule are the undigested remains of the nutriment.

The bodies which have thus become liberated appear to be destitute of nucleus and contractile vesicle. When released they assume the form of spherical masses of a red-coloured protoplasm (D), from the surface of which are emitted pointed pseudopodial rays like those of an *Actinophrys*. They are, however, very contractile and undergo constant change of form, drawing themselves out into strings and fine filaments, which tear asunder and again unite and send off branches and form fan-like expansions; while these ramified creeping masses of protoplasm can again contract themselves into a sphere.

When the *Vampyrella* in this condition is watched in water containing some plants of *Spirogyra*, it may be seen wandering about slowly until it strikes against one of the filaments of the alga. After gliding for some time over the surface of the filament it attaches itself to it if the filament be healthy and loaded with

* Haeckel, "Nachträge zur Monographie der Moneren," Jenaische Zeitschr. 1871.

Fig. 11.



Vampyrella spirogyræ.

A, the *Vampyrella* in the act of sucking out the contents of a *Spirogyra*-cell. B, the *Vampyrella* in its encysted state: *a*, nitrogenous covering; *b*, interior contents. C, the contents of the *Vampyrella*-cyst have become divided into tetraspores, and one of these is seen escaping as an *Amœba*-like *Vampyrella*. D, the free amœboid *Vampyrella*. (After Cienkowski.)

chlorophyl. We next find that it has begun to perforate the walls of the filament; and no sooner has it thus gained access to the interior than the protoplasmic lining ("primordial utricle") detaches itself from the cell-wall of the *Spirogyra*, and along with its adherent chlorophyl granules passes slowly into the body of the *Vampyrella* (A). As soon as the *Vampyrella* has thus gained possession of the contents of one cell it passes to another, and there repeats the process. In this way cell after cell is plundered of its contents; and now the *Vampyrella*, gorged with food, seats itself on some part of the alga, rolls itself into a ball, and quietly digests its prey.

The chlorophyl granules which had thus made their way into the interior of the *Vampyrella* now become gradually distributed through its entire body, and it then passes into the resting state (B), withdrawing its pseudopodia and excreting a soft nitrogenous

covering, under which is formed a weak cellulose membrane. During this time the contents assume a red colour, and the encysted *Vampyrella* finally appears in the form of the red capsule with which the description of its life-history was commenced.

The only other species of *Vampyrella* which it will be necessary to refer to is one more recently described by Haeckel*, who discovered it on the coast of Norway, and has assigned to it the name of *Vampyrella gomphonematis* (fig. 12). It appears to live exclusively on a species of *Gomphonema*, whose cells it envelopes and then sucks out their contents.

On the branches of the *Gomphonema* (A) are occasionally found, in place of the proper terminal cells of silica, a great abundance of clear red spherical capsules (*a*). These are the cysts of the *Vampyrella*.

The free-creeping *V. gomphonematis* (B) always appears as an irregular lump of protoplasm without nucleus or contractile vesicle, while from its surface there are emitted a great number of extremely fine pseudopodia.

In this condition it creeps over the stems and branches of the *Gomphonema*, adapting itself to the form of its support; and as soon as it has reached one of the terminal siliceous cells of the diatom, it extends itself over the entire cell so as completely to envelope it in a thin layer of protoplasm.

The plundering of the *Gomphonema*-cell now begins, and while a number of fine pseudopodia radiate from the body of the *Vampyrella* into the surrounding water, another portion of its protoplasm forces its way between the siliceous plates of the cell into the interior, and here appropriates the contents.

The empty siliceous cell (A, *g*, *h*) of the *Gomphonema* is now broken off from its stem and, as foreign indigestible matter, is cast out of the body of the *Vampyrella*, which continues to sit in the place of the cell and there digests its food in quiet. In this way it passes from cell to cell of the *Gomphonema*; and when it has thus plundered many cells, and by abundant nutriment has attained its full size, it begins gradually to withdraw its pseudopodia to round itself into a smooth sphere of protoplasm, to encyst itself by the exudation of a capsule, and pass into a resting state (*a*).

The encysted *Vampyrella* continues now to sit on the summit of the stem in the place of its last victim, and after remaining for some time in this condition of repose, the contents of the capsule

* "Nachträge zur Monographie der Moneren," Jenaische Zeitschr. 1871.

Fig. 12.

Vampyrella gomphonematis.

A, a colony of *Gomphonema* attacked by numerous *Vampyrellæ*: *a*, an encysted *Vampyrella*; *b*, *b*, the cyst with its contents broken up into four tetraspores; *c*, *e*, a tetraspore transformed into the *Vampyrella*, which is escaping from the cyst, and has already begun to creep along a neighbouring branch; *d*, *d*, tetraspores still included in the cyst; *f*, a *Vampyrella* in the act of devouring the contents of a *Gomphonema*-cell; *g*, *h*, empty cells of the *Gomphonema* being cast out of the body of the *Vampyrella*. B, an isolated *Vampyrella* moving about by means of its extended pseudopodia. (After Haeckel.)

become divided into four similar parts (*b*, *b*). These are the tetraspores, which Cienkowski had already shown to constitute part of the developmental cycle of *Vampyrella*. In one spot of the capsule a small opening now appears, and through this the tetraspores slowly press themselves out (*e*), immediately emit pseudopodia, and assume the form of the creeping *Actinophrys*-like proto-

plasm lump which, as we have already seen, constitutes the fully developed state of the active and voracious *Vampyrella.*

Cienkowski divides his group of the *Monadina* into two subordinate ones :—

I. MONADINA ZOOSPOREA.—Reproduction effected by the formation of numerous mobile spores.

1. *Monas* (*Protomonas*, Haeckel).
2. *Pseudospora.*
3. *Colpodella.*

II. MONADINA TETRAPLASTA.—Reproduction effected by the formation of two or four *Actinophrys*-like bodies.

4. *Vampyrella.*
5. *Nuclearia**.

Among the most important researches on the lowest forms of life which must be brought under this review are those of Messrs. Dallinger and Drysdale on a group of minute flagellate organisms obtained from putrifying infusions of fish, and described by these investigators under the general name of "Monads"†.

By the aid of very high powers ($\frac{1}{50}$ of an inch object-glass), and by employing an ingeniously constructed "moist chamber," Messrs. Dallinger and Drysdale have followed up the life-history of these organisms, and have discovered, common to them all, certain phenomena which are full of significance in the history of development.

Among several forms whose development has been carefully traced by them, we may take, as a sufficiently illustrative example, one to which they refer under the name of "the calycine monad ‡" (fig. 13). It has a conical shape (A), $\frac{1}{1000}$ to $\frac{1}{300}$ of an inch in length; the broad end carries four flagella, which spring from a common root, while the opposite end tapers away to a point. A shallow longitudinal depression extends backwards along each side, giving to the broad end an hourglass-shaped outline. It contains a large nucleus and two rhythmically contracting vacuoles.

The first phenomenon observed in its life-history is a multipli-

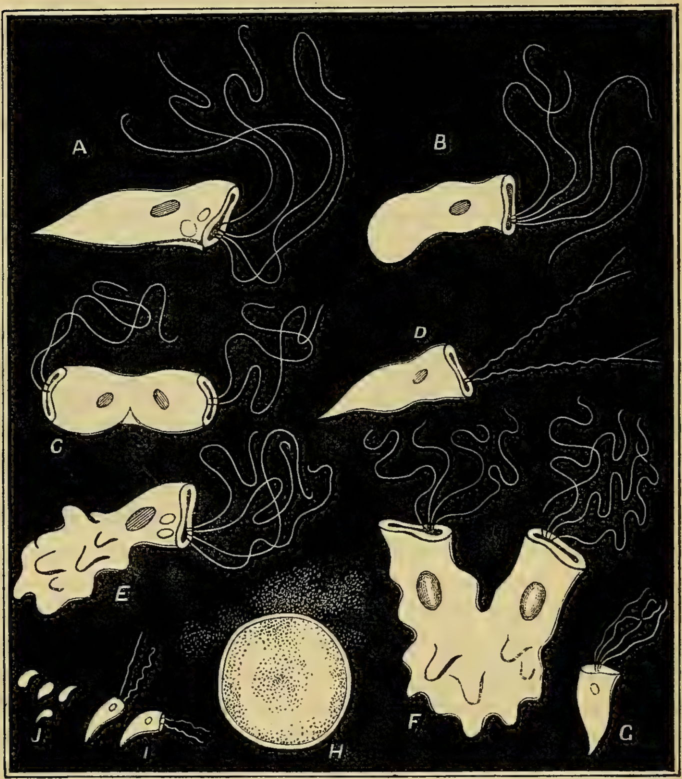
* *Nuclearia* has been described above, and reasons given why it ought not to be associated with the *Monadina* of Cienkowski (see p. 386).

† Rev. W. H. Dallinger and J. Drysdale, M.D., "Researches on the Life-History of the Monads," Monthly Microsc. Journ. vols. x.–xiii. 1873–75.

‡ In no instance do the authors give a systematic name to the organisms which form the subject of their investigations, and to which they always refer under vernacular designations.

cation by transverse fission. When this is about to take place the posterior or non-flagellate end becomes blunt and rounded, and the monad assumes a semiamœboid condition, the sarcode becoming irregular in outline (B). The common root of the flagella now splits, so that the four flagella are separated into two pairs, which recede more and more from one another until finally we find them situated on two diametrically opposite points of the

Fig. 13.



Development of "Calycine Monad."

A, fully developed monad, with nucleus and contractile vacuoles and four flagella. B, the monad in the semiamœboid state which precedes fission. C, the monad in the act of spontaneous fission. D, one of the two segments resulting from fission, each of the two flagella becoming doubled by longitudinal splitting. E, the amœboid condition which precedes fusion. F, two amœboid monads in the act of becoming fused into one another. H, the two blended bodies enclosed in a sac which is pouring out a cloud of sporules. J, I, G, the sporules becoming developed into the parent form. (After Dallinger and Drysdale.)

body (C). In the mean time the nucleus has become divided into two, and between its halves the fission of the body proceeds until completed, and the two segments are set free. Each of these (D) is as yet provided with only two flagella, which immediately begin to split from the free end to the base, and the complete form of the parent monad with its four flagella is thus acquired. The two flagella during this act of splitting are attached to some fixed object by their distal ends and then thrown into a state of rapid vibration.

Besides the multitude of free-swimming, semiamœboid individuals thus noticed in the act of self-division, some (E) may be seen in which the amœboid condition is much more decided on the posterior end of the body from which pseudopodia are being constantly protruded, while the anterior end with its four flagella continues with but little change. The nucleus has become much larger.

In this condition the monad swims more and more slowly until, in some cases, it ceases entirely to swim, and moves about solely by the aid of pseudopodia, exactly like an *Amœba.*

If it now meet another in a similar condition, the amœboid parts unite and instantly blend into one another (F). This blending together of the two bodies becomes more and more intimate; the two sets of flagella unite and become fused into the general sarcode, the contractile vacuoles flow together and become inactive, the two nuclei also flow together, and, finally, the blending has become complete; all trace of the original form is lost, and all that remains is a distended roundish sac (H) which, after the lapse of some hours, will be seen to pour out in all directions, without evident rupture, clouds of excessively minute points which can be clearly defined as oval refringent corpuscles only by means of a magnifying-power of 2500 diameters. These were followed by the aid of a $\frac{1}{50}$ of an inch object-glass, and their development traced into the form of the original conical monad with its four flagella.

The life-history thus traced in the "calycine monad" corresponds in all essential points with what the authors observed in the other species which formed the subject of their investigations. Multiplication by fission took place in every species, while a fusion together of two individuals would seem to be in every case a necessary phenomenon in the developmental cycle of the monad. In one form only, instead of inactive sporules of immeasurable minuteness following as a product of this fusion, the blended

mass broke up into a multitude of minute flagellate young resembling the original parents in all points but size.

Messrs. Dallinger and Drysdale have further made a series of well-conducted observations on the capacity possessed by these "monads" of resisting high temperatures, and have arrived at results of great importance in their bearing on the evidence adduced by the advocates of the doctrine of spontaneous generation. They have thus shown that while the adult form is destroyed by a temperature comparatively low, the minute inactive sporules which result from the fusion of two monads may survive and become developed into the complete organism after exposure to a temperature of from 121° C. (258° Fahr.) to 140°·88 C. (300° Fahr.). This, however, occurs only in the case of the inactive sporules; the young active brood into which, in one of the species, the blended mass of sarcode breaks up only feebly survived a temperature of 82°·22 C. (180° Fahr.).

The capacity of resisting heat possessed by the inactive sporules has been estimated by the authors as bearing to that of the developed monad an average ratio of 11 : 6.

Haeckel records some additional observations on the structure of the Radiolaria*. He had already † made it probable that the protoplasm of these is formed by the union of many true cells. As undoubted cells of the Radiolaria he had indicated the remarkable "yellow cells" and the intracapsular cells and alveolar cells. Recent observations have convinced him that the spherical clear vesicles which form the most important and constant constituent of the central capsule are genuine cells. He finds in them a true nucleus, and he regards it as very probable that they are reproductive cells.

This suspicion has been since confirmed by the observations of Cienkowski, who has seen the contents of the central capsule in *Collosphæra* break up into monadiform masses, which developed on one end a pair of cilia and escaped in the form of zoospores ‡. The ultimate destiny, however, of these bodies remains unknown.

It is well known that in *Actinosphærium Eichornii* (which with *Actinophrys sol* and most of the so-called freshwater Radiolarians constitute the group of the Heliozoa) numerous nuclei exist in the

* "Beiträge zur Plastidentheorie," Jen. Zeitschr. vol. v.

† Die Radiolarien, 1862.

‡ Cienkowski, "Ueber Schwärmebildung bei Radiolarien," Archiv f. mikr. Anat. vol. vii. 1871.

endosarc. These are regarded by Haeckel as indicating a true multicellular structure, which he compares with the multicellular contents of the central capsule in the Radiolaria. He has further shown that in the young state of various families of Radiolaria, though the central capsule is absent, the central part of the protoplasm-body includes a number of cells. He hence concludes that the young Radiolaria whose central capsule is as yet absent are morphologically equivalent to *Actinosphæria*. It should be borne in mind, however, that even though we adopt Haeckel's view of the multicellularity of *Actinosphæria*, the cells of this rhizopod would be indicated solely by nuclei without any differentiated territories of the surrounding protoplasm.

Haeckel has made the very interesting discovery that the so-called "yellow cells" of the Radiolaria contain a substance which cannot be distinguished from the starch of plants*. Acted on by iodine the granular contents of these cells acquire an intense blue colour. The quantity of starch which is thus contained in the "yellow cells" of the Radiolaria is very great. In some cases more than half of the entire body of the Radiolarian consists of starch.

Among the most interesting and important contributions to our knowledge of the lowest sarcode organisms is Haeckel's 'Monograph of the *Monera*'†. Haeckel had already, in his 'Generelle Morphologie,' grouped together under the name of *Monera* certain organisms of the lowest conceivable kind. They consist of an absolutely homogeneous and structureless mass of sarcode, destitute in their fully developed and free-moving state of external investing membrane and of internal nucleus and contractile vacuole, and multiplying themselves by a self-division of their substance. They are the simplest of all organisms; indeed it is impossible to conceive of a living being reduced to an expression more simple.

No character has yet been discovered in them which would justify us in assigning them to the animal kingdom rather than to the vegetable, or to the vegetable rather than to the animal: and Haeckel unites them with the Rhizopoda, Flagellata, Diatomaceæ, and some other organisms slightly higher than these, in order to form an assemblage of low sarcodic forms which he regards as neither plants nor animals, but as holding an intermediate posi-

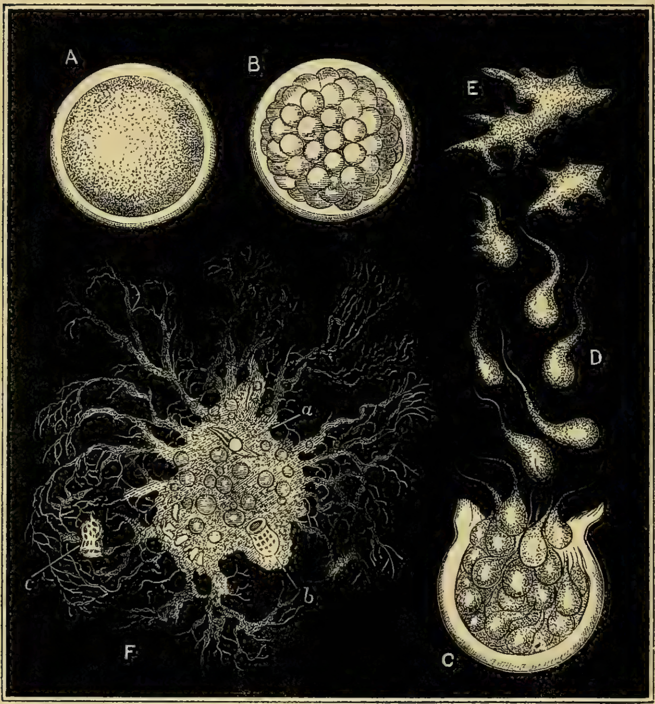
* Beiträge zur Plastidentheorie.

† "Monogr. der Moneren," Jenais. Zeitschr. 1868.

tion between the two. To this assemblage he assigns the rank of a separate kingdom, to which he gives the name of PROTISTA.

Haeckel had founded his group of the Monera on an organism which he had observed in the Mediterranean off Nice, and which he named *Protogenes primordialis*. It consists of a homogeneous ball of protoplasm, from whose surface thousands of fine thread-like pseudopodia, which frequently branch and become confluent

Fig. 14.



Protomyxa aurantiaca.

A, the *Protomyxa* in its encysted or resting state. B, the protoplasmic contents of the cyst have become broken up into a multitude of spherical segments. C, the protoplasm-spheres escaping from the cyst as flagellate swarm-spores. D, the free swarm-spores actively swimming about by means of their flagelliform processes. E, the swarm-spores after the withdrawal of the flagellum creeping about by means of pseudopodia in the manner of an *Amœba*. F, the fully developed *Protomyxa*: in the interior are seen numerous vacuoles (a) and an ingested diatom and infusorium (b, c); from the central protoplasm radiate a multitude of dendritically branched and anastomosing pseudopodia. (After Haeckel.)

with one another, radiate in all directions. Nutriment is ingested in the same manner as by the true Rhizopoda, and reproduction is effected by a simple spontaneous division of the body into two halves without this phenomenon being preceded, as in other cases, by a motionless or encysted state.

In the present memoir Haeckel describes several genera of Monera. The *Protomyxa*, of which we know only one species, *P. aurantiaca* (fig. 14), was found on an empty *Spirula*-shell in the Canary Islands. In its developed state (F) it forms minute stellar and arborescent figures of an orange-red colour, which spread over the surface of the shell and vividly remind us of the ramified contractile pigment-cells common in the skin of Amphibia and Fishes. Each star-like body presents a central mass of sarcode from which radiate numerous branches, which subdivide and inosculate and form a beautiful moving and changeable net of protoplasm not unlike that of the Myxomycetæ. Orange-red granules, to which the colour of the plasma is due, streamed in all directions through the sarcode-net. Foreign bodies also, such as pelagic Infusoria and Diatomaceæ, were seized by the protoplasm and engulfed as food in its substance, where they might be seen, along with the red granules, to be carried away in its currents.

No nucleus or definite contractile vesicle was present, though numerous floating and inconstant vacuoles were dispersed through its substance.

After a time an important change begins to take place. The currents become slower, the ramified processes become gradually withdrawn; and after the siliceous and other indigestible remains of the food are ejected, the whole body becomes rounded into a spherical mass. Round this a transparent cyst now becomes excreted, and the *Protomyxa* passes into a state of complete quiescence (A). These motionless encysted balls of orange-red protoplasm were also observed by Haeckel attached to the surface of the *Spirula*-shell, and their subsequent history was followed by him.

He found that after a time the contents of the cyst became slightly retracted from the walls, and then became broken up into a multitude of small, round, structureless, naked balls (B). After remaining in this condition unchanged for several days, the contained balls began to move within the cyst; and as the motion became more lively, the balls assumed a pyriform shape, in which one end was drawn out into a fine point. Soon after this

the cyst burst (C), and a multitude of the red pear-shaped bodies issued from it and moved about in the surrounding water. It was soon seen that one end had become attenuated into a very fine tail or flagellum (D), so that the free sporules resembled the Flagellatæ, or the zoospores of an Alga. They were without a trace of nucleus, or of contractile vesicle, or of investing membrane, and consisted solely of minute naked masses of homogeneous protoplasm.

This swarming-period lasted about one day, and then the sporules lay quiet on the bottom of the vessel. The tail was drawn in, and the pear-shaped form was changed into that of an irregular roundish disk, from whose circumference pseudopodial processes began to be emitted. The sporule had now passed into the condition of an *Amœba* (E), and began, like an *Amœba*, to take in nutriment by engulfing it in its substance; and then vacuoles of inconstant size and position made their appearance within it.

Two or more of these *Amœbæ* were seen to unite and form a plasmodium. The pseudopodia became more and more branched and reticulated, and the condition of the orange-red dendritic patches, which crept over the *Spirula*-shell, and with which our history commenced, was finally attained.

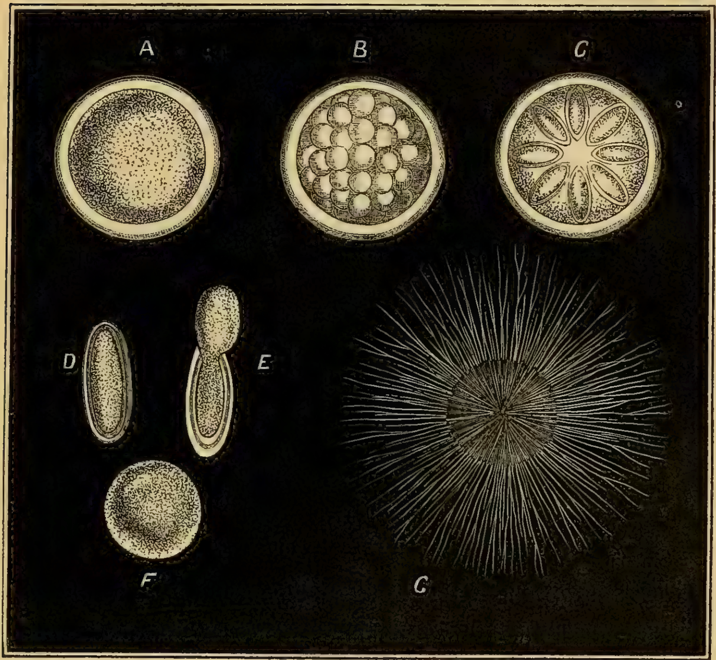
It is thus seen that *Protomyxa* passes in the course of its development through an encysted or sedentary stage, and a free or mobile stage. The latter shows itself in three different successive forms:—1, that of a free-swimming flagellate; 2, that of a creeping *Amœba*; and 3, that of a contractile protoplasm-net.

The genus *Myxastrum*, represented by *M. radians* (fig. 15), was also found by Haeckel in the Canary Islands. It consists of a small globular mass of homogeneous protoplasm (G), from whose whole periphery radiate a multitude of fine pseudopodia. It thus bears a close resemblance to the well-known *Actinophrys sol*, from which, however, it is separated by the absence of vacuolæ and by its remarkable mode of reproduction.

When the time for its reproduction approaches, *Myxastrum radians* retracts its pseudopodia, assumes the form of a smooth ball, encysts itself in the manner of *Protomyxa*, and becomes motionless (A). After a time the plasma mass within the cyst becomes divided by radiating furrows into numerous segments, which gradually assume a spindle-shape and become clothed with a thin siliceous membrane (B, C). These spindle-shaped bodies resemble *Naviculæ*, and if isolated might easily be taken for small Diatoms.

They want, however, the nucleus of the Diatomaceæ. They are simple non-nucleated masses of protoplasm invested by their siliceous membrane.

Fig. 15.



Myxastrum radians.

A, the *Myxastrum* in its encysted resting state. B, the homogeneous contents of the cyst have become broken up by radial cleavage into numerous conical masses whose points touch one another in the centre of the sphere, and whose rounded bases are visible at the periphery. C, the conical segments of B have become fusiform, and each has excreted for itself a siliceous shell. The focus of the microscope is here directed upon a meridional plane so as to show the radial disposition of the fusiform spores. D, the free fusiform spore with its siliceous shell. E, the protoplasmic contents of the spore escaping from its siliceous shell. F, the homogeneous protoplasm of the spore which has entirely freed itself from its siliceous shell, and assumed a spherical form. G, the same protoplasm mass become the fully developed *Myxastrum*, with a multitude of fine pseudopodia radiating in all directions from its periphery. (After Haeckel.)

In this condition they remain for some time within the cyst, and then, by the rupture of this, escape and become dispersed in the surrounding water (D). Soon after this the homogeneous proto-

plasm issues through an aperture in one end of its siliceous covering (E), contracts itself into a ball (F), begins to emit radiating processes from its surface and to take in nourishment from without, and then by a process of simple growth acquires the condition of the adult *Myxastrum*.

Under the name of *Myxodictyum sociale*, Haeckel describes another representative of the Monera, which he obtained from the surface of the sea in the Bay of Algesiras. When taken it consisted of a group of roundish masses of homogeneous protoplasm, resembling small Actinophryses, from each of which radiated numerous fine branching and anastomosing filaments, which became confluent with those of the neighbouring masses, uniting the whole into a simple large plasma-net.

The uniting filaments resembled in all respects the pseudopodia of the true Rhizopoda, and the characteristic sarcode-currents might be seen in them passing from mass to mass. *Myxodictyum* would thus appear to represent a colony of Moners rather than a single individual; and Haeckel compares it in this respect with the polycytarian or social Radiolaria.

Nothing decided has been discovered regarding the reproduction of *Myxodictyum*, but it is probable that some of the masses detach themselves from the margin of the old colony and form new ones.

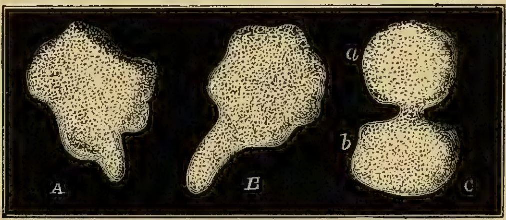
Those independent *Amœba*-like organisms which have neither nucleus nor contractile vesicle, and whose body consists of a perfectly structureless mass of protoplasm, have been, under the name of *Protamœba*, separated by Haeckel from the true *Amœbæ*, which always possess a nucleus and generally a vacuole, or even a true contractile vesicle.

Haeckel here describes his *Protamœba primitiva* (fig. 16), which he found among decaying leaves in the fine mud of a pond near Jena. It consists of a mass of absolutely homogeneous protoplasm, which emits from its periphery short blunt pseudopodia, and shows no differentiation of a more firm outer and a softer inner portion, as is seen in some other species of *Protamœba* and in most, probably all, of the true *Amœbæ*. It takes in nutriment by enveloping solid matter in its substance in the manner of the true *Amœbæ* and the *Amœba*-like blood-cells of animals: and it multiplies by the simplest form of non-sexual reproduction—the spontaneous division of its body without previously passing into a resting state.

Bodies entirely similar to these *Protamœbæ* occur as transi-

tional stages in the development of some other Monera (*Protomyxæ*) as well as in that of the Gregarinæ. But the *Protamœbæ* of Haeckel are independent organisms directly reproducing themselves by spontaneous fission. The forms constituting the genus *Protamœba* are thus distinguished from the other Monera by their simple pseudopodia, which never anastomose with one another so as to form net-like expansions, and also by the fact that their reproduction is by simple self-division without this being preceded by an encysted or resting state. A similar form of reproduction exists in *Protogenes*, another genus of Monera; but here the pseudopodia are long thin branching processes which anastomose with one another and form protoplasm-nets.

Fig. 16.



Protamœba primitiva.

A, the *Protamœba* with short lobe-like pseudopodia. B, the same, with a longer pseudopodium. C, the same, in the act of self-division into two segments (*a*, *b*). (After Haeckel.)

Besides *Protamœba primitiva*, several other species of *Protamœba* have been since described by Haeckel*.

A peculiar slimy substance dredged from depths of from 5000 to 25,000 feet in the Atlantic Ocean, during the exploring expedition of the 'Porcupine,' had been examined by Huxley, who concluded that it consists of living protoplasm, vast masses of which extend over wide areas of the sea-bottom. He assigned to this remarkable substance the name of *Bathybius*.

Associated with it and imbedded irregularly in the slime are certain calcareous concretions of a very definite shape. These have been named Coccoliths by Huxley. They are in the form either of simple disks (Discoliths), or of two such disks united to one another so as to form a body (Cyatholith) whose shape has been very aptly compared by Huxley to a shirt-stud. Besides

* "Nachträge zur Monographie der Moneren," Jen. Zeit. 1871.

these, but occurring much more sparingly, have also been found small globular concretions resembling little heaps of Coccoliths. These have been named by Wallich, who first drew attention to them, Coccospheres. Both Coccoliths and Coccospheres are believed by Huxley to be proper parts of the *Bathybius* and formed by excretion from the protoplasm.

The *Bathybius* has been since subjected to a very exhaustive examination by Haeckel*, who believes that he is able to confirm in all points the conclusions of Huxley, and arrives at the conviction that the bottom of the open ocean at depths below 5000 feet is covered with an enormous mass of free living protoplasm, which lingers there in the simplest and most primitive condition, having as yet acquired no definite form. He refers it to his group of Monera, and suggests that it may have originated by spontaneous generation (*Urzeugung*), a question, however, which he leaves for future investigations to decide.

The determination of *Bathybius* as an independent organism has not been confirmed by observations since made during the expedition of the 'Challenger.' What has been regarded as the same slimy material which had been examined by Huxley and Haeckel, in specimens preserved in alcohol, has been again examined on the spot, and the 'Challenger' explorers have declared their conviction that it is only an inorganic precipitate due to the action of the alcohol. With the views of able observers thus differing from one another, it will be wise to reserve judgment.

The origin of the Coccoliths and Coccospheres still remains undetermined. Haeckel has described under the name of *Myxobrachia*† a remarkable genus of Radiolaria characterized by the possession of one or several thick fleshy arms, which terminate each in a capitulum. These terminal capitula enclose numerous calcareous concretions exactly resembling the single-disk coccoliths and the coccospheres of *Bathybius*. Notwithstanding, however, the impossibility of distinguishing the concretions of the one from those of the other, Haeckel cannot consider *Myxobrachia* as the proper source of the multitudes of coccoliths which cover the bottom of the sea.

* "Beiträge zur Plastidentheorie," Jena. Zeitschr. vol. v.

† *Ibid.*

In a subsequent memoir*, Haeckel gives the following systematic arrangement of all hitherto known Monera:—

	Genera.	
I. GYMNOMONERA. Monera without resting state or encystation.	1. Protamœba	5 species.
	2. Protogenes	1 species.
	3. Bathybius	1 species.
	4. Myxodictyum	1 species.
II. LEPOMONERA. Monera with resting state and encystation.	5. Protomonas	2 species.
	6. Protomyxa	1 species.
	7. Vampyrella............	4 species.
	8. Myxastrum	1 species.

Of all these sixteen species, seven live in fresh water, the remaining nine in the sea.

One of the most extraordinary of all those very low organisms whose recent study has been rewarded by the discovery of new and significant facts is one to which Haeckel† has given the name of *Magosphæra* (fig. 17).

Attached to the filaments of a species of the confervoid genus *Cladophora* were noticed small spherical cells (A) of a pale yellow colour, surrounded by a thick membrane, and showing in the middle of their transparent protoplasm a large spherical nucleus with a nucleolus. The structure of these bodies was thus undistinguishable from that of a true animal egg, with its vitelline membrane, vitellus, germinal vesicle, and germinal spot.

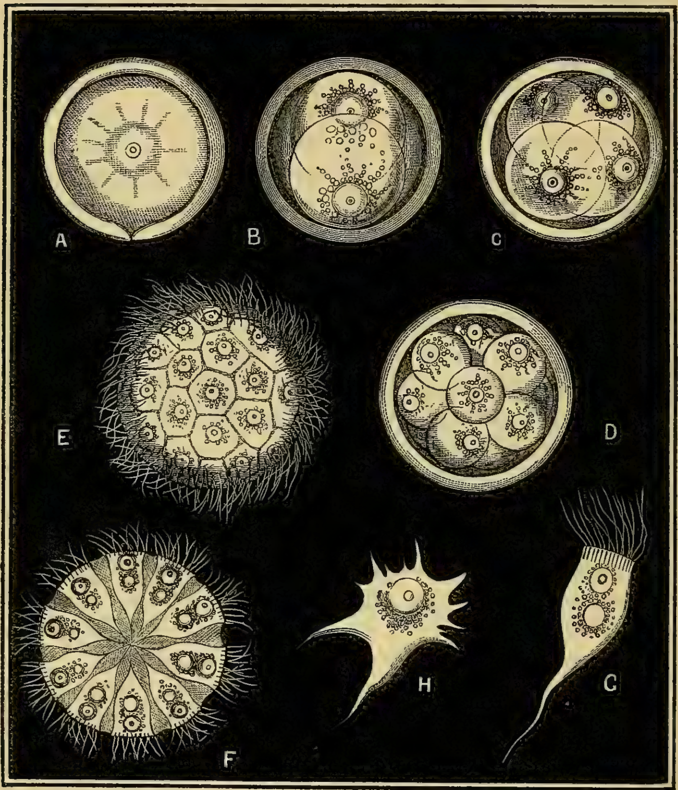
This egg-like form constitutes the first stage of *Magosphæra*. In attaining the second (B), a phenomenon in all respects like that of the total cleavage of the yelk sets in. The nucleus of the cell breaks up by self-division into two nuclei, and the protoplasm of the cell has now become divided into two segments, each enveloping one of the nuclei. Thus are formed the first two cleavage-spheres, each of which in its turn, dividing into two, exactly repeats the phenomenon (C). And the process is continued (D) precisely as in ordinary yelk-cleavage, until with the fifth segmentation thirty-two cleavage-spheres or daughter cells are produced, and the process of segmentation is completed.

* "Nachträge zur Monographie der Moneren," Jena. Zeitschr. 1871.

† Haeckel, "Die Catallacten, eine neue Protisten-Gruppe," Jena. Zeitschr. Band vi. 1871.

The thirty-two daughter cells into which the egg-like cell has thus broken up now begin to show amœboid movements within their common investing membrane. At the same time they emit

Fig. 17.



Magosphæra planula.

A, unicellular encysted condition. B, the cyst containing two cells; the single cell divided into two by the first act of segmentation. C, the contents of the cyst divided into four cells by continued segmentation. D, the contents of the cyst divided into sixteen cells by still further segmentation. E, the multicellular sphere resulting from repeated segmentation has forsaken the cyst, and now swims about by means of vibratile cilia. (Viewed from the surface.) F, the ciliated sphere viewed in optical section through its centre, so that ten of its component cells are seen in a meridional plane. G, an isolated ciliated cell with long tail. H, the cell having lost its cilia and assumed an amœboid form. (After Haeckel.)

from their surface small, blunt, irregular, pseudopodial projections. These gradually become more pointed, thinner, and longer; their motions become more lively, and the amœboid pseudopodia pass into vibratile cilia.

The change of pseudopodia into vibratile cilia had been already shown by Haeckel* to occur in other instances, and has been regarded by him as proving the identity of amœboid protoplasm-motion with ciliary motion. I am enabled to bring forward a confirmation of this view in the apparent passing of pseudopodia into cilia on the gastric surface of *Myriothela*†.

The spherical cell-heap whose surface has in this way clothed itself with vibratile cilia begins by the aid of these to rotate slowly within the egg-membrane. This is at last ruptured, and the ciliated sphere escapes and swims about by means of its cilia in the surrounding water (E).

The *Magosphæra* is now in the condition of a multicellular ciliated sphere so closely resembling one of Ehrenberg's *Volvocineæ*, that if its history were not known it would, without hesitation, be placed in this group as a genus closely allied to if not identical with the *Synura* of Ehrenberg.

The cells, which have a spherical form, or are more or less polyhedral from mutual pressure, now become regularly pyriform, and are seen to be united in the centre of the sphere by their elongated ends (F), while the peripheral end is rounded off and furnished with cilia, which appear to sit upon the margin of this end in a circle interrupted at one side by a spiral arrangement, as in the peristome of *Vorticella*, &c.

The cells have no membrane, and the intervals between them are filled with a watery, structureless, jelly-like secretion from their surface, as in the *Volvocineæ*. Every cell encloses in its protoplasm a nucleolated nucleus surrounded by granules, and possesses also a contractile vesicle.

After the *Magosphæra* has thus continued for some time swimming about in the sea as a ciliated sphere, it begins to resolve itself into its constituent elements. The single ciliated cells now separate from one another and swim about independently (G). In this state they might be easily taken for peritrichal ciliate Infusoria, or for isolated cilia-cells of the epithelium of the higher animals. These separate cells are very contractile, and are con-

* Beiträge zur Plastidentheorie.

† "On the Structure and Development of *Myriothela*," Phil. Trans. 1875.

stantly changing their shape from fusiform to spherical. They take in coloured food through the cilia-disk, though no constant mouth could be detected.

From the stage represented by the isolated cilia-cell, *Magosphæra* next passes into the condition of a genuine *Amœba* (H). In this stage it appears as a simple naked nucleated cell, like all genuine *Amœbæ*. The pseudopodia are thin, conical, and pointed, like those of Auerbach's *Amœba actinophora* or his *A. bilimbosa*. The nucleus and contractile vesicle are still present, as in the isolated cilia-cell, and we can distinguish, as in most of the true *Amœbæ*, an external firmer layer and an internal softer one. Solid food is taken in as in the isolated cilia-cell. The ingestion, however, is not, as in the latter, confined to a definite spot, but may take place indifferently from any part of the surface.

The *Amœba*-stage would seem to close the cycle of development; and though Haeckel has not succeeded in actually following up its life-history, it seems pretty certain that after the *Amœba* has increased in size by the reception of nutriment, it once more encysts itself and returns to the egg-stage with which our examination began.

In this most remarkable life-history, *Magosphæra* has passed successively through the following stages:—

1. A unicellular resting stage, indistinguishable morphologically from a genuine egg (A).

By a process of cleavage which in all respects resembles a true vitellary segmentation this passes into

2. The condition of a multicellular ciliated sphere, in which it resembles a form of the *Volvocineæ* (E).

3. A simple isolated cilia-cell, representing the condition of a peritrichal ciliate Infusorium (F).

4. An amœboid cell indistinguishable from a genuine *Amœba* (H).

The characters thus presented by *Magosphæra* appear to Haeckel to justify him in regarding it as a member of his group of the Protista; and from the fact of its representing in the cycle of its development so many different independent forms, he makes it the type of a distinct section of this group, to which he assigns the name of CATALLACTA.

Magosphæra, however, would seem to be related to the Infusoria at least as nearly as to the Rhizopoda. It is plainly a transition-form by which the one group passes into the other.

I have thus attempted, in the present Address and in that of last year, to bring before you in rapid review a large number of organisms with whose true structure and life-history biologists have only quite recently become acquainted. They are among the most interesting of those simple beings which, standing on the confines of organization, constitute the group of the Rhizopoda in the wider signification of this word. The marine forms represented by the Radiolaria and Foraminifera have been only incidentally touched on; but the freshwater forms, with such dwellers in the sea as most directly represent them, have been here examined in all their most important features.

Notwithstanding, however, the excellent work which we owe to numerous continental observers, and in our own country to W. Archer, much still remains to be known of the structure and life-history of the freshwater Rhizopoda, and a rich field for exploration lies open to the microscopic observer—a field, too, of easy access; for, unlike the objects which form the study of the marine zoologist, these Rhizopods of fresh water may be found in almost every inland locality wherever there are undisturbed pools, or weedy ditches, or slowly running streams, in the shallow pools which collect upon the wild moors where there is nothing to intercept the heat and light of the summer sun, and even in gloomy ponds shaded from sunlight by overhanging trees and half-filled with decaying leaves.

While thus bringing before you the results of recent researches, my exposition has necessarily assumed the character of a general survey of the freshwater Rhizopoda and of the Monera and other nearly allied organisms; for almost all the knowledge we possess of these simple forms of life has been derived from investigations carried on within the last few years.

I have hopes, therefore, that the exposition which I have endeavoured to give you in last year's Anniversary Address and in that of the present year may be of some value in affording aid to the worker in one of the most interesting fields of microscopical research.

On the Genus *Actinometra*, Müll., with a morphological account of a new Species (*A. polymorpha*) from the Philippine Islands. By P. Herbert Carpenter, B.A., Biological Master at Eton College. Communicated by Dr. William B. Carpenter, F.R.S., F.L.S., &c.

[Read June 21, 1877.]

(Abstract *.)

The name *Actinometra* was given by Johannes Müller† to those species of the genus *Comatula* (Lamarck) in which the tentacular furrows of the arms unite on the disk into less than five principal trunks or ambulacra converging towards the peristom. Until the time of Müller, Leach's genus *Alecto* was used as equivalent to the *Comatula* of Lamarck; but the application of this name was limited by Müller, who used it in contradistinction to *Actinometra*, to describe the more common species of *Comatula*, in which five principal groove-trunks or ambulacra radiate outwards from the peristom, and subdivide symmetrically into more or fewer branches proceeding to the different groups of arms.

The position of the mouth in *Alecto* might be either subcentral (in no *Comatula* is it absolutely central), or more or less excentric, sometimes even marginal; but any *Comatula* in which five ambulacra reached the peristom, whatever the position of the mouth, was referred by Müller to this genus, the sole distinction between it and *Actinometra* being the presence of five or fewer principal ambulacral trunks.

From the time of Müller until now, the genus *Actinometra* has remained as he left it, though more than one author has remarked upon the unsatisfactory nature of its distinctive characters. Leach's name *Alecto*, however, has gradually passed into disuse, having been partially replaced by De Freminville's name *Antedon*, a precise definition of which has been given by Mr. Norman‡.

Antedon, like *Alecto*, was originally equivalent to *Comatula*; but, according to Mr. Norman's definition (which has been universally adopted), it is now used to designate those forms only in which

* [The memoir in full, with illustrations, will subsequently appear in the Society's Transactions.—Ed.]

† "Ueber die Gattung *Comatula*, Lam., und ihre Arten," Abhandlungen der Berlin. Akademie, 1849.

‡ "On the Genera and Species of the British Echinodermata," Ann. & Mag. Nat. Hist. ser. 3, vol. xv. p. 98.

the mouth is subcentral. All these, as for example the British *Antedon rosacea*, have the five centripetal ambulacra characteristic of *Alecto*; but there are many species of *Alecto*, as for example *C.* (*Alecto*) *multiradiata*, in which the five primary ambulacra converge to an excentric or even marginal peristomial area, the mouth being nowhere near the centre of the disk. Such forms as these clearly have no place in the genus *Antedon*, while they are excluded from *Actinometra*, as defined by Müller, although agreeing with it in the excentric position of the mouth. In many *Comatulæ* also, the mouth is excentric, and six, eight, or even ten groove-trunks reach the peristom; these, again, have no place either in *Antedon*, *Alecto*, or *Actinometra* (as defined by Müller).

After a careful examination of a large number of *Comatulæ*, including the valuable collection in the Paris Museum, and also a number of new species brought by Professor Semper from the Philippine Islands, the author has been led to the conclusion that Müller's mode of classification of the *Comatulæ* is purely artificial, and leads to the separation of individuals which really belong to one and the same species: on the other hand, the position of the mouth, either subcentral or excentric, affords a very natural means of classification, being readily visible externally, and being also accompanied by important differences in the anatomy and relative positions of the internal organs.

The author has examined eleven specimens of *Comatula polymorpha*, in all of which the mouth is excentric, and the composition of their skeleton and other parts so similar that they evidently belong to one species. One of them, however, would have been referred to *Alecto* by Müller, having five primary groove-trunks, and another, with only four, to *Actinometra*; but there is no place in his system for the remainder, which have six, seven, or eight groove-trunks reaching the excentric peristom. Müller himself affords us similar examples of the artificial nature of his classification; for in one place he describes a specimen as *Actinometra*, while a little further on he classes it as *Alecto*, on account of the similarities it presents to *A. multiradiata* in the characters of the skeleton.

Again, Müller, who examined the Paris collection of *Comatulæ*, does not describe the *C. trichoptera* which he found there, either as *Alecto* or as *Actinometra*, the reason probably being that there are only four primary groove-trunks in one of the two specimens,

while in the other there are five, the mouth being excentric in both cases.

These and many similar instances have led the author to the conclusion that the real distinction between *Antedon* and *Actinometra* lies in the subcentral or excentric position of the mouth, and that the number of groove-trunks reaching the peristom is a character of very minor importance. The definition of *Actinometra*, therefore, will have to be extended so as to include those forms in which there are five or more primary groove-trunks, as well as those forms with less than five, for which the name was originally introduced by Müller.

After arriving at the above conclusion, the author learnt from Dr. Lütken, of Copenhagen, that he had held similar views for some time past. Dr. Lütken further informed the author that *Antedon* and *Actinometra* also differ from one another in the character of their oral pinnules. In the former genus, with the mouth subcentral, the oral pinnules are but slightly differentiated from those of the rest of the arm, while in *Actinometra* they are always very different from the others, being more or less flagelliform with small lateral shield-shaped processes on their terminal joints, which thus have a comb-like appearance.

Although, like Dr. Lütken, the author has found that in all the *Comatulæ* he has examined the terminal comb on the oral pinnules invariably coexists with an excentric mouth, and is absent in those forms with a subcentral mouth, yet this does not seem always to be the case; for Lovén* has described a new *Comatula* under the name of *Phanogenia*, in which the mouth is central, but the oral pinnules have a terminal comb.

This form is perhaps generically distinct from *Antedon* and *Actinometra*, as it presents some peculiarities in the structure of the skeleton; but in a new American species described by Pourtales† this is not the case, and the mouth is excentric, while the oral pinnules are not specially distinguished: the same appears to be the case in the *Comatula rosea* of Müller; and the author is therefore not disposed to attach very much importance to the presence or absence of a terminal comb on the oral pinnules as a

* Phanogenia, ett hittills okändt slägte af fria Crinoideer. Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar, 1866, No. 9, pp. 223-233.

† "List of the Crinoids obtained on the coasts of Florida and Cuba, by the United-States Coast-Survey Gulf-Stream Expeditions, in 1867, 1868, 1869" ('Bulletins of the Museum of Comparative Zoology,' Cambridge, U.S., No. 11).

distinctive character between *Antedon* and *Actinometra*. The differences in the position of the mouth, however, afford a distinctive character of much value, especially as they are accompanied by marked variations in the anatomy and mutual relations of important internal organs.

Out of the numerous species of *Comatula* at present known, the author has been able to refer seventeen to the genus *Actinometra* as above defined. Fourteen of these were known to Müller; and out of the remaining twenty-three species described by him, the author has determined sixteen as true *Antedons* with a subcentral mouth, together with nine species described by various authors since the publication of Müller's memoir. Seven of Müller's species remain as yet undetermined, together with one described by Pourtales, as there is no mention of the position of the mouth in the specific diagnoses, and the author has been unable to make a personal examination of the specimens in question.

Taking, therefore, the genus *Actinometra* as including all those *Comatulæ* in which the mouth is excentric, the author finds that it may be divided into two principal groups according to the position of the mouth with respect to the radial or ambulacral planes. In *Antedon*, where the mouth is subcentral, the interradial area containing the anal tube may be considered as posterior; and a plane passing through the mouth and anus so as to divide the disk into two symmetrical halves, will traverse the odd ambulacrum in front of the mouth, which may therefore be regarded as radial in position.

In *Actinometra solaris* the odd ambulacrum is also in front of the mouth, which, though excentric in position, lies in the radial half of a plane passing through the mouth and anus, so as to divide the disk into two symmetrical halves, the interradial half of this plane passing through the anus.

In *Act. multiradiata*, however, and in many other species, the case is different, as the mouth is interradial in position, and the odd ambulacrum lies behind it; for a plane cutting the mouth and anus is radial behind the mouth, in front of which it passes along the interval between two ambulacra or radii.

This type of *Actinometra*, in which the mouth is interradial and the odd ambulacrum lies behind it, is considerably more frequent, so far as the author's experience goes, than the simpler type, in which the mouth is radial and the odd ambulacrum anterior, as in

Antedon: he has only met with this last in *A. solaris* and its varieties, in *A. fimbriata*, and in three new species of *Actinometra* from the West Indies; all the other species known to him belong, like *A. multiradiata* and *A. polymorpha*, to the type in which the mouth is interradial and the odd ambulacrum posterior.

The median line of the ventral perisom of all the arms of *Antedon* is occupied by an open ambulacral groove bounded by an elevated fold of perisom, the edge of which is not straight, but cut out into a series of minute valvules, the crescentic or respiratory leaves. At the base of each leaf, and to some extent protected by it, is a group of three tentacles, one of which, the more distal, is larger than the other two. This trifid group of tentacles and the cavity of the respiratory leaf in connexion with them, are in communication with the cavity of the radial water-vessel by a common lateral branch: the tentacular groups alternate on the opposite sides of the ambulacral groove, from the base to the tip of each arm, and are distributed in the same manner at the sides of the ambulacra of the disk. The floor of each groove consists of a layer of ciliated epithelium, beneath which lie the radial water-vascular and blood-vascular trunks, but separated from it by a fibrillar structure (the subepithelial band), to which a nervous character has been attributed by the author and by all the other observers who have described it.

In *Act. polymorpha* and in many other *Actinometræ* the above description only applies to the more anterior arms; for the arms of the posterior radii are usually entirely devoid of tentacles, and in many of them the ventral perisom not only exhibits no ambulacral groove, but is convex as in the oral pinnules of *Antedon*.

In neither of the two large aboral groove-trunks which form a horseshoe-shaped curve enclosing the anal area of *Act. polymorpha*, are the tentacular groups so well developed as in the two anterior ambulacra. The bases of these trunks, where they start from the peristom, are of the usual character; but sooner or later the tentacles become more and more insignificant, and finally disappear altogether, while the position of the crescentic leaves is only indicated by a very faint wavy line at the edge of each groove. In small specimens with but few arms, the grooves of the posterior and posterolateral arms may remain in this condition; but in larger specimens with many arms all trace of the respiratory leaves disappears, and the two edges of the groove gradually approach one another and finally unite, so that the ventral surface of the

arm and pinnules becomes convex, and does not show the least trace of a groove of any description.

The position of the point at which the two folds of perisom bounding the original ambulacral groove meet and unite, varies extremely: the union may, though rarely, take place on the disk; sometimes it is at the base of the arms, and sometimes not till near their middle or terminal portions. In any case, however, the fusion where it occurs is so complete that *all trace of the original ambulacral groove is entirely obliterated.*

This fact has a very important bearing upon the two opposite views which have been recently advanced regarding the nervous system of *Comatula.*

According to the one view, held by Dr. Carpenter and by the author, the axial cords traversing the centre of the calcareous segments of the skeleton, together with the fibrillar envelope of the quinquelocular organ from which they all radiate, constitute the principal and, as the author is disposed to think, the *only* nervous system of *Comatula.*

In the centre of every segment of the skeleton, from the first radials to the tips of the arms and pinnules, and also in the cirrus-segments, these axial cords increase considerably in size and give off four main branches. Two run towards the ventral side and in the calyx disappear in the neighbourhood of the muscles connecting the segments; but in the arms they continue their course towards the ventral perisom and break up into numerous small branches, some of which may be traced as far as the tips of the crescentic leaves. The two inferior or dorsal trunks run towards the dorsal surface of the skeleton; and while some of their branches are lost in the plexus of tissue forming its organic basis, others seem to become connected with epidermic structures. In the arms of *Antedon celtica* Dr. Carpenter has found branches of the axial cords ramifying upon the ends of the muscular bundles connecting the segments; and the results of his experiments have shown that the power of motion in any arm depends upon the connexion between its axial cord and the fibrillar envelope of the chambered organ, while the power of coordinating the regular swimming movements of all the arms depends upon the integrity of this envelope, which there is thus good reason to believe to be of a nervous nature.

The chief objection to this view is that it places the nervous system of the Crinoids on the dorsal side of the body, and not on the ventral side immediately superior to the water-vessel as in

all the other Echinoderms. This objection has been strongly urged by various German authors, who all assign a nervous character to the fibrillar subepithelial band above mentioned, since it occupies the same relative position as a very similar structure that has been hitherto generally regarded as representing the nervous system of the Asterids. It extends along the ventral surface of the arms and pinnules beneath the ambulacral grooves, and forms a ring round the mouth beneath the ciliated epithelium of the peristomial area, just above the water-vascular and blood-vascular rings. This band was discovered independently and nearly simultaneously by the author and by three German observers, all of whom regard it as representing *the* nervous system of *Comatula*, and deny the nervous nature of the axial cords. Dr. Carpenter's experiments at Naples*, however, have fully proved that the coordinated swimming-movements of the arms are entirely independent of this subepithelial band, and are carried on even when the visceral mass containing the oral ring is entirely removed from the calyx; so that this structure, if a nerve at all, cannot be regarded as motor in function. It gives off no branches, except an extremely minute one beneath the epithelium of each respiratory leaf and tentacular group.

If, however, the axial cords are not nerves, and if these ventral subepithelial bands are to be regarded as the only nervous structures in the whole Crinoid organization, the difficulty presents itself that the oral pinnules of the European Crinoids, and more than half the arms, with the majority of the pinnules of some forms of *Actinometra*, are entirely devoid of a nervous supply.

The oral pinnules of *Antedon* have been shown by Dr. Carpenter to be extremely susceptible of irritation. When they are touched in the living animal, the whole circlet of arms is suddenly and simultaneously coiled up over the disk, while irritation of one of the ordinary pinnules is simply followed by flexion of the arm which bears it.

The structure of these oral pinnules, which are borne in *Antedon rosacea* by the second brachials, differs very considerably from that of the pinnules borne by the other brachial segments; for not only are they sterile, but they have neither tentacular apparatus nor ambulacral groove, their ventral surface being slightly convex, while the ordinary ciliated epithelium of the groove with the subjacent subepithelial band, the so-called "ambulacral nerve," are

* Supplemental Note to a paper "On the Structure, Physiology, and Development of *Antedon rosaceus*," Proceedings R. S., No. 169, 1876.

entirely absent. This condition, which is limited in *A. rosacea* to the oral pinnules, sometimes exists in whole arms, and in all the pinnules borne by them in some species of *Actinometra*: even in the arms which come off from the anterior or oral side of the disk, the ambulacral groove does not give off regular branches to the pinnules borne by the third and successive brachial segments; but a variable number of these first pinnules, sometimes only three or four, sometimes as many as forty, resemble the oral pinnules in this respect, their ventral surface being convex and devoid of any ciliated epithelium or subepithelial band, while their water-vessel is simple without any lateral extensions to respiratory leaves and tentacles. In these oral arms, however, branches of the ambulacral grooves enter the pinnules sooner or later, so that the terminal ones are always provided with a distinct tentacular apparatus, while the floor of their median groove is of the usual character, consisting of a ciliated epithelium and a subepithelial fibrillar band. We have already seen that in many cases the ambulacral grooves going to the aboral arms become less and less distinct as they get further and further from the peristom, and that their tentacles diminish and finally disappear: at the same time the floor of the groove becomes very much reduced, its epithelial layer thinner and thinner, and the subepithelial band almost invisible, until, in those cases in which the sides of the groove meet and unite, the ciliated epithelium and subepithelial band or ambulacral nerve disappear altogether, as in the oral pinnules. Consequently, when this union takes place on the disk, *whole arms must be entirely devoid of any nervous supply*, unless we admit the nervous nature of the antiambulacral axial cords.

In such cases it would naturally be expected that these posterior arms would not perform the regular swimming-movements, like those anterior arms which have an open tentacular groove and a subjacent "ambulacral nerve;" but Professor Semper, who has kept *Actinometræ* in his aquaria for weeks together, has informed the anthor that he never saw the least trace of any irregularity in the alternating movements of their arms when swimming.

If we suppose, with Ludwig*, that the subepithelial band is the sole structure of a nervous nature in the whole Crinoid organization, it is difficult to understand the fact (which Ludwig himself

* 'Morphologische Studien an Echinodermen. I. Beiträge zur Anatomie der Crinoideen,' Leipzig, 1877, p. 81 (Separat-Abdruck aus der Zeitschrift für wissenschaftliche Zoologie, Bd. xxviii.).

admits) that it gives off no branches except the very small ones which go to the tentacles. It is true that in the *Ophiuridæ* the radial ventrally-placed nerve does give off branches which go to the muscles, besides those proceeding to the tentacles, as described by Lange*, Teuscher†, and Simroth‡; but the researches of the first-mentioned observer render it very doubtful whether the representative in the *Ophiuridæ* of the subepithelial band of *Comatula* takes any part in the formation of these branches.

That the subepithelial band is of the same nature in the Crinoids and Asterids there can, it seems, be little doubt; and it is therefore somewhat interesting that its nervous nature in the Asterids has recently been disputed by Lange §, who regards as nervous only two cellular masses separated from the subepithelial fibrillar band by a connective-tissue membrane, and projecting into the lumen of the nerve-canal, which swell under the pigment-spot into a large ganglionic mass; while the subepithelial band, together with the ciliated epithelium and the cuticula, constitutes a protecting integumentary layer.

Lange finds a corresponding condition in *Ophiura texturata*, in which the radial nervous system is better developed than in the Asterids, and consists of a series of paired ganglionic masses connected with one another by transverse and longitudinal commissures. On the ventral side of this ganglionated cord is a longitudinal band, which Lange regards as the homologue of the protecting integumentary layer forming the floor of the ambulacral groove of the Asterids, and which, as universally admitted, corresponds to the subepithelial band, epithelium, and cuticula of the ambulacral grooves of the Crinoids.

Lange's views have been partially accepted by Simroth ‖; but they have been altogether denied by Teuscher¶, who regards Lange's nervous cell-masses in the Asterids simply as an epithelial layer several cells deep on the inner wall of the nerve-canal, while the terminal ganglionic mass under the eye-spot is represented by Teuscher as a cushion of connective tissue.

* "Beiträge zur Anatomie und Histiologie der Asterien und Ophiuren," Morphologisches Jahrbuch, Band ii. 1876, p. 241.

† "Beiträge zur Anatomie der Echinodermen.—II. Ophiuridæ," Jenaische Zeitschrift, Band x. 1876, p. 274.

‡ "Anatomie und Schizogonie der *Ophiactis virens*, Sars," Theil I., Zeitschrift für wissenschaftliche Zoologie, Band xxvii. p. 473.

§ *Loc. cit.* p. 274.

‖ *Loc. cit.* pp. 556, 560.

¶ 'Beiträge,' &c. III. "Asteriden," Jen. Zeitschr. x. p. 513.

Still less do Teuscher and Lange agree about the nervous system of the Ophiurids. Lange's ganglionic masses are described as artificial by Teuscher, who, as in the case of the Asterids, regards as the nerve only the fibrillar structure representing the subepithelial band of *Comatula*.

The question is still an open one: and it is therefore of no small interest to find that this subepithelial band, the so called ambulacral nerve, is not always present in the arms of *Comatula*, and that even when it exists it is certainly not motor in function.

It has been stated above that in certain of the arms of *Actinometra* the water-vessels are simple tubes like the integumentary water-vessels of the Molpadidæ, and not in connexion with any tentacular apparatus. Whether the mouth be radial or interradial, the non-tentaculiferous arms are the aboral ones; so that in the latter case they belong to the trivium, as in *A. polymorpha*, and in the former to the bivium, as in *A. solaris*.

In only one out of twelve specimens of *A. polymorpha* has the author found a non-tentaculiferous arm in the bivium: it was in one of the two anterior radii. But this specimen was very remarkable; for out of 31 arms 19 were entirely devoid of a tentacular apparatus, and in 15 of these the union of the two sides of the ambulacral grooves had taken place either on the disk or in the basal arm-segments; so that an "ambulacral nerve" was wanting in nearly half the total number of arms. In the other four of these non-tentaculiferous arms the groove remained open for a short distance, and then closed in the manner already described. Three of these four arms belonged to the trivium; but the fourth was an anterior arm belonging to the bivium, and was borne upon the same palmar axillary as a well-developed ordinary tentaculiferous arm.

With this exception, the author has invariably found the non-tentaculiferous arms on the aboral side of the disk: their number and distribution, however, vary extremely, not only in different species, but in different individuals of the same species. Thus in *A. polymorpha* the author has found the proportion of non-tentaculiferous arms to the total number to vary from $\frac{6}{20}$ to $\frac{19}{31}$. Even in two individuals with the same number of arms it may not be the same: thus in two specimens with 20 arms the proportion was $\frac{6}{20}$ and $\frac{11}{20}$ respectively, and again $\frac{10}{28}$ and $\frac{15}{28}$; while in one specimen all the arms were normal and tentaculiferous as in *Antedon*.

The same variation occurs in *Actinometra solaris*, in which species the number of arms is limited to 10: they may be all tentaculiferous; or from one to four of the posterior arms may have no tentacular apparatus. This abnormal condition does not seem, however, to be very common; for out of all the *Actinometræ* in the Paris collection the author found but one in which he could say with any certainty, without cutting sections, that some of the posterior arms were non-tentaculiferous; and this was a large many-armed specimen of *A. Bennetti*, Müller.

The condition of the ambulacral groove and of the tentacular apparatus is not the only point in which the anterior or oral arms of *Actinometra* may differ from the posterior or aboral arms. The former taper very slowly, contain far more segments, and are much longer than the latter, while the form of their terminal portions, and of the pinnules which these bear, is altogether different.

In *A. polymorpha* the centre of the dorsal half of each of the segments of the terminal pinnules of the posterior arms is often occupied by a dark brown ovoid body of a peculiar cellular nature, which the author has reasons for believing to be a sense-organ. These bodies may also, though rarely, occur in one or more of the anterior tentaculiferous arms; but they do not exist in all the specimens of *A. polymorpha* which the author has examined, for in 7 out of 12 specimens they are entirely wanting.

The arms of *A. polymorpha* may therefore be roughly classified as follows:—

1. *Anterior.*—120–150 segments: pinnules increasing in length to the terminal ones, which are very long and slender. Tentaculiferous.

2. *Anterolateral.*—Also tentaculiferous: 100–120 segments: terminal pinnules long and slender.

3. *Posterolateral.*—80–100 segments: terminal pinnules stout, but rather longer than the median ones. Ventral perisom with narrow ambulacral grooves, but non-tentaculiferous.

Posterior.—Only 60–80 segments: terminal pinnules stout, but decreasing slightly in length from the middle of the arm onwards. No ambulacral grooves nor tentaculiferous apparatus.

Another difference between the anterior and posterior arms is that the genital glands of the latter are far more developed than in the former. Not only is their number greater, although the total number of pinnules on a posterior arm may not be much

more than half that on an anterior arm, but they also attain a very much greater size, the basal and median pinnules of an anterior arm being very much less swollen than the corresponding pinnules of a posterior arm. A similar inequality in the development of the genital glands has been noted by Agassiz as occurring in the Echini *.

The external appearance of the centrodorsal piece of *Actinometra* is very characteristic: like the cirri which it bears, it is far more constant throughout a considerable range of species from very various localities than it appears to be in the individual members of a single species both of the European and of some of the foreign *Antedons* even when collected in the same locality.

In *Actinometra* the centrodorsal piece is almost invariably a flattened, circular or rudely pentagonal disk, somewhat hollowed in the centre, and with low sloping sides marked out into distinct sockets for the articulation of the cirri, which are limited to its margin, the central portion of the plate being entirely free from them. There is usually only one row of cirrus-sockets at the margin of the plate; but in the large *A. robusta* there may be two, and even traces of a third. In the typical forms of *A. polymorpha* the number of cirri existing at any one time seems to vary between 15 and 25; and the size and number of their segments are tolerably constant, which is by no means the case in *Antedon*. Further, the individual segments do not acquire the characters of maturity at any thing like such an early date as they usually do in *Antedon*, but even after the cirrus has attained a considerable size and has the normal number of segments the latter remain of a very rudimentary character, which is a somewhat exceptional mode of development in *Antedon*.

Another very marked difference between *Antedon* and *Actinometra* consists in the fact that in the latter genus the planes of the external or distal faces of the first radials are parallel to the vertical axis of the calyx, and not inclined to it at a considerable angle as is the case in *Antedon*; so that the whole of the ventral surface of the calyx is in one horizontal plane, while in *Antedon* the second and third radials and the bases of the arms are at a much higher level than the pentagon of the first radials, owing to the inclination of the distal articular faces of the latter.

The most interesting point in the skeleton of *Actinometra* is the condition of the rosette or metamorphosed basals, which re-

* 'Revision of the Echini,' pt. iv. pp. 680, 681.

tain far more of an embryonic character than is usually the case in *Antedon*; but the author has met with specimens of *Ant. rosacea* in which the metamorphosis is far less complete than usual, and which present in this respect an approximation to *Actinometra*. A normal rosette of *Antedon rosacea* consists of a disk perforated in the centre, with ten rays proceeding from it. Five of these rays are short, triangular in form, and nearly flat; and their position is interradial, as they are directed to the sutures between the five radials, their apices joining the contiguous pairs of these just between the two adjacent apertures of the central canals. Alternating with these five interradial processes of the rosette are five radial spout-like processes, each of which has parallel margins inflected on its ventral aspect in such a manner as to form a groove, while the process itself is so curved towards its dorsal aspect that this groove reaches the periphery of the rosette and then terminates abruptly as if truncated.

The inflected margins of each of these five radial processes of the rosette are applied to the similarly inflected margins of the dorsal half of an axial furrow lying between the two apertures of the central canal on the internal face of each first radial, so that the two grooves are united into a complete canal. Each of the five canals thus formed contains a diverticulum of the body-cavity; and they terminate blindly in shallow depressions upon the ventral surface of the centrodorsal piece on which the first radials rest.

The rosette is essentially formed out of a secondary calcareous reticulation formed upon the ventral surface of the original basals. The primary or dorsal layer originally constituting them becomes almost entirely absorbed, the ends of the spout-like processes being all that remains of them in the adult *Comatula*; for the salient angle of each basal plate which is received between two first radials and the greater part of the centre of its dorsal surface is usually entirely removed.

Sometimes, however, the removal of the primary or dorsal layer at the salient angle of one or more of the five embryonic basals may be incomplete, so that the ends of the curved rays of the rosette exhibit lateral processes which are the remains of the upper margins of the primitive basal plates on which the first radials rested. Occasionally the apex of the original basal is left unabsorbed, so that the two lateral curved processes which persist after the removal of the primary external layer along the

median line of each plate remain in connexion with one another. Not unfrequently the triangular interradial process, which is developed from a secondary calcareous deposit on the ventral side of the original basal, becomes more or less completely united with these primary bars connecting the lateral portions of the basal. The latter retain their primitive relation to the first radials; for they remain united with them along the inner margins of their dorsal surfaces; and as they partially cover in the dorsal aspect of the bifurcating nerve-cords which enter the central canals of the first radials, the author has called them the basal bridge. The interradial processes of the rosette of *A. rosacea* may also exhibit departures from their normal triangular shape: not unfrequently they become long and spout-like, with inflected parallel margins, which are so applied to the projecting and similarly inflected outer edges of the adjacent openings of the central canals in two contiguous radials as to convert the interradial furrow lying between them into a complete axial interradial canal, precisely similar in character to the axial radial canals already described.

This occasional spout-like condition of the interradial processes of the rosette of *A. rosacea* is of considerable interest, as it is normal in *Actinometra*, in which genus also the ends of the alternating radial and interradial processes are always connected by a basal bridge, the unabsorbed remains of the outer margins of the embryonic basal plate.

From the outer ends of each of the interradial processes of the rosette of *Actinometra*, where it unites with the two bars of the basal bridge proceeding from the radial process on either side, there extends, for a longer or shorter distance towards the periphery of the calyx, a prismatic or cylindrical rod, which is received in an interradial furrow on the ventral surface of the centrodorsal piece. These five rods, to which, taken together, the author has given the name of the basal star, vary very greatly in the degree of their development, not only in different species, but in different individuals of the same species, and to some extent also in the same individual.

The reason of this is that these rods are not like the other pieces of the skeleton, calcifications in a nucleated protoplasmic network, but they are simply formed by a more or less complete deposition of calcareous matter in the five interradial planes around the fibres of connective tissue which effect the synostosis of the

centrodorsal piece with the pentagonal base of the calyx. In one specimen of *A. polymorpha* the author has found them to be almost entirely absent, while in others they are very large and stout. Lovén has found something of the same kind in *Antedon Eschrichtii*; but in both the specimens of this species which the author has been able to examine, they were scarcely developed at all.

These tertiary elements in the basals of *Actinometra* are of extreme interest; for they are precisely similar in shape and position to the basals of two species of the fossil genus *Solanocrinus*, viz. *S. costatus* and *S. scrobiculatus*.

In both these species there seems to be no rosette; but the basals consist of five prismatic rods in contact by their central ends, and occupying five deep grooves on the ventral surface of the centrodorsal piece. They extend beyond its margin, however, and so become visible on the exterior of the calyx, which is not the case with the rays of the basal star of *Actinometra*. Hence this would seem to preclude the possibility of their being formed like the latter, by ossification in the connective tissue of the synostosis between the radial pentagon and the subjacent centrodorsal piece; so that they are probably the remains of the original embryonic basal plates, which are represented in *Actinometra* only by the rosette: and the rays of the basal star of *Actinometra* would therefore not be strictly homologous with the rod-like basals of *Solanocrinus costatus*, although the analogy in their position is complete.

The calyx of *S. Jaegeri* presents a great advance upon that of *S. costatus* with respect to the development of the basals, which led Pictet* to propose the erection of this species into a separate genus. Instead of being long and narrow, and in contact only by their central ends, as in *S. costatus*, they are broad and wedge-shaped, and in contact along their whole sides, so as to form a complete calcareous disk entirely separating the radial pentagon from the centrodorsal piece.

This is precisely their position in *Pentacrinus*, though there are but few species of that genus in which the basals are relatively so large and complete as in *S. Jaegeri*. In *P. asteria* and in the two fossil species *P. briareus* and *P. subangularis* they are small and cuneiform, and only in contact by their central ends, just as in *S. costatus*; so that the greater portion of the radial pentagon is

* 'Traité de Paléontologie,' tom. iv. p. 288.

in contact with the top stem-segment: in *P. Mülleri* they are in contact for about half their length and then diverge, while in *P. Wyville-Thomsoni* they are completely united with one another along the whole length of their sides, so as entirely to cut off the radial pentagon from the top stem-segment, just as in *S. Jaegeri*. There can therefore be little doubt that the basals of *Pentacrinus* are homologous with those of *Solanocrinus*, and therefore analogous, as a whole, to the compound basals of *Actinometra*, which are not entirely developed out of the embryonic basal plates. Only their central part, the rosette, has the same origin as the basals of *Pentacrinus*, with the inner or central ends of which it is strictly homologous; for the bifurcating nerve-cords proceeding from the angles of the chambered organ have the same relation to the rosette and basal bridge of *Actinometra* as to the united central ends of the basals of *Pentacrinus*, which are perforated by bifurcating canals in which these cords are lodged.

It would seem, in fact, as if in *Pentacrinus* and *Solanocrinus* the embryonic basal plates became directly transformed into the basals of the adult; while in *Comatula* they undergo metamorphosis into the central rosette by the absorption of the greater portion of their dorsal or *primary* tissue, and the development of a *secondary* ossification on the ventral side of the original plates.

In *Antedon rosacea* the metamorphosis is much more complete than in *A. Eschrichtii* and in *Actinometra*, in which last new skeletal elements are developed by a more or less complete *tertiary* ossification in masses of connective tissue, that correspond precisely in position and also, to a certain extent, in shape with the basals of *Solanocrinus* and *Pentacrinus*. These, being most probably direct products of the growth of the embryonic basals, are therefore strictly homologous only to the rosette of *Actinometra*, although analogous in position to the whole circlet of compound basals in this genus, namely to the rosette and basal star taken together.

The recent genus *Comaster*, or *Comatula multiradiata* of Goldfuss*, from the Indian Ocean, has been considered by most authors generically identical with the fossil *Solanocrinus*, on account of the appearance of the basals upon the exterior of the calyx.

The condition of the central ends of the basals, however, and, in fact, of the whole calyx, is very remarkable and very unlike that presented by any other *Comatula* with which we are acquainted,

* Petrefacta Germaniæ, i. p. 202.

while the differences between it and *Solanocrinus* are so very great that it is difficult to understand how they can ever have been regarded as belonging to one and the same genus.

The centrodorsal piece of *Comaster* is hemispherical: but its margin is not infolded as a broad lip, forming a wide superior ventral surface on which the first radials rest. These last bear the axillaries directly without the intervention of any second radials, which are always present in *Comatula*, and have very narrow inferior faces that simply rest upon the thick rim of the hemispherical centrodorsal basin. The infero-lateral angles of every pair of contiguous radials are truncated; and the spaces left between them when they are in their natural condition of apposition by their lateral faces, are occupied by the five small triangular basals which rest on the rim of the centrodorsal basin, and are visible on the exterior of the calyx alternating with the first radials, just like the peripheral ends of the basals of *Solanocrinus costatus*. In this species, however, the basals are longish rods of considerable relative width and in contact by their central ends, while in *Comaster* they are small triangular pieces, from the middle of the inner and lower edge of each of which there arises a tooth-like process in the shape of a small cartilaginous rod extending to the centre of the centrodorsal piece which is grooved to receive it.

Goldfuss does not describe any thing that could be regarded as a rosette in *Comaster*; and the small triangular basals would seem to be the ultimate condition of the embryonic basal plates, with which they exactly agree in their relative position; but the relations of their central processes are somewhat difficult to understand. They can hardly be regarded as comparable, except in their interradial position, to the rays of the basal star of *Actinometra*; for they lie in grooves on the floor of the cavity of the centrodorsal basin, and are apparently independent of the first radials, which have no extensive area of synostosis with the centrodorsal piece as in *Comatula*—while from Goldfuss's account of them they do not seem to be calcified, but to be more of a cartilaginous nature.

It is possible that the calyx of *Antedon Dübenii*, as described by Böhlsche*, may present some points of resemblance to that of *Comaster*; for, as in this genus, only two rows of radials are visible externally, and between every two radials of the first row is a

* "Ueber *Actinometra Bennettii* und eine neue Comatula-Art (*Antedon Dubenii*)," Wiegmann's Archiv für Naturgeschichte, 1866, p. 94.

small calcareous ossicle. Böhlsche did not separate the pieces of the calyx, and was therefore unable to determine whether there are really three rows of radials, as in the ordinary *Comatulæ*, or not: but if, as in *Comaster*, there are only two rows, then the small ossicles appearing externally between every two pieces of the first row would represent the basals of *Comaster*. The condition of their central ends is unfortunately still unknown to us.

Comaster further differs from all the *Comatulæ* with which we are acquainted, and also from *Solanocrinus*, in the fact that the nervous cords are not lodged in canals which perforate the pieces of the calyx, but lie freely on the superior surfaces of the segments, the opposed terminal faces of which lie flatly against one another. The muscles and ligaments lie along their concave inner sides and cover in the freely exposed nerve-cords: from the palmar axillaries onwards, however, all the segments have articular surfaces of the usual character, and are perforated by central canals in which the nerve-cords lie. This condition of the segments of the calyx of *Comaster* is of great interest; for, besides being the normal permanent condition in the tessellate Crinoids, it is the embryonic condition, so far as the position of the nerve-cords is concerned, in *Comatula*.

These facts will suffice to show the very great differences that exist, in the skeleton alone, between *Comaster* and the other members of the family Comatulidæ, including *Solanocrinus*—with which genus it has been united, on account of the appearance of the basals on the exterior of the calyx. In *Solanocrinus*, however, as in the other Comatulidæ, the first radials are perforated by central canals for the nerve-cords; and the absence of this character in *Comaster* would alone justify our referring these two forms to separate genera, even were this the only difference between them, which, as shown above, is by no means the case.

Contributions to the Ornithology of New Guinea. By R. Bowdler Sharpe, F.L.S., F.Z.S., &c.—Part III. On a new Species of Goshawk from the Island of Jobi.

[Read June 21, 1877.]

(Plate XXII.)

In the collection of Accipitres submitted to me by Dr. Meyer, and obtained by him during his voyage to Papuasia, there was a

specimen of a Goshawk which is undoubtedly new to science, and which I propose to name as undermentioned.

ASTUR MEYERIANUS, sp. n. (Plate XXII.)

a. Niger, subtus albus; similis *A. albigulari*, sed major et genis albis nigro striolatis distinguendus.

This species, which is from Ansus on the Island of Jobi, is very closely allied to *A. albigularis* of the Solomon Islands; but is a larger bird, as will be seen by the following measurements:—

	Total length. millim.	Wing. millim.	Tail. millim.	Tarsus. millim.
a. A. albigularis (type)...	460	254	203	67
b. A. Meyerianus (type)..	510	315	205	72

In addition to the larger size and white cheeks, the Jobi bird is slightly varied with black shaft-streaks and wavy cross bars of blackish; but whether these are signs of youth or indications of specific characters, I am unable to determine.

Descriptions of Genera and Species of Australian Phytophagous Beetles. By JOSEPH S. BALY, Esq., M.R.C.S., F.L.S.

[Read June 21, 1877.]

List of Genera and Species.

Idiocephala nigripennis.
Rhombosternus sulphuripennis.
—— *antennatus.*
—— *gracilicornis.*
Bucharis Chapuisii.
—— *granulosus.*
—— *martius.*
Polyachus marginicollis.
Ditropidus phalacroides.
—— *lætus.*
—— *costipennis.*
—— *facialis.*
—— *Jansoni.*
—— *semicircularis.*
—— *ornatus.*
—— *pulchellus.*
Ditropidus serenus.
Terillus foveolatus.
—— *squamosus.*
—— *perplexus.*
—— *Duboulayi.*
—— *vittatus.*
Geloptera igneo-nitens.
—— *vestita.*
Rhyparida maculicollis.
Cyclonoda, n. g.
Paralepta, n. g., *foveicollis.*
Platycepha, n. g., *eximia.*
Arsipoda piceipes.
Œdionychis Howittii.
Sphærophyma, n. g., *Simoni.*

Family CRYPTOCEPHALIDÆ.

Genus Idiocephala, *Saunders*.

Idiocephala nigripennis. Subquadrato-oblonga, valde convexa, rufo-fulva, nitida; antennis (basi exceptis) elytrisque nigris; thorace basi utrinque oblique impresso, mediocriter et remote punctato; elytris fortiter seriatim punctatis, interspatiis ante medium et ad latera transversim elevato-strigosis. ♀. Long. 2 lin.

Hab. Queensland, Rockhampton.

Head scarcely broader than long, subrotundate, closely punctured, interspaces finely rugose-strigose; vertex and front with an ill-defined raised longitudinal line; eyes moderately distant, deeply notched; antennæ more than half the length of the body, slightly thickened towards the apex, black, four lower joints rufo-fulvous, more or less stained with piceous. Thorax twice as broad as long; sides broadly margined, subparallel at the base, thence obliquely converging to the apex, more quickly converging and slightly rounded near the latter; above convex, broadly and obliquely depressed on either side, smooth and shining, remotely punctured; the broadly reflexed lateral margin paler than the disk. Scutellum wedge-shaped, its apex truncate. Elytra not broader than the base of the thorax; sides strongly lobed, constricted behind the middle; above convex, rather strongly punctate-striate, interspaces on the anterior disk and on the sides transversely wrinkled. Body beneath closely punctured. Prosternum oblong, its hinder apex truncate, its surface plane, the anterior border scarcely deflexed.

Genus Rhombosternus, *Suffr.*

Rhombosternus sulphuripennis, *Suffr.* MS. Elongatus ♂, magis oblongus ♀, subcylindricus, flavus, nitidus; vertice, thoracis margine basali, scutello, tibiis apice tarsisque nigris; thorace hic illic fortiter punctato; elytris fortiter punctatis, punctis apicem versus striatim dispositis; interspatiis transversim elevato-reticulatis, inter strias longitudinaliter convexiusculis; suturâ, fasciâ basali alterâque pone medium undatâ, nigris.

Mas abdominis segmento ultimo apice trilobato, dorso foveâ magnâ subrotundatâ leviter impresso, et utrinque prope apicem spinâ compressâ acutâ, deorsum spectante, instructo.

Var. A. scutello flavo, nigro-limbato. Long. 3–3¼ lin.

Hab. South Australia, Adelaide.

Head rotundate; vertex and front coarsely punctured, the former, together with the upper portion of the latter, rugose; antennæ longer than the body in both sexes, slender, filiform, piceo-fulvous, the basal joint stained above with piceous, the third and fourth equal in length, the fifth and following joints each rather longer than the fourth, nearly equal; eyes deeply and narrowly notched. Thorax twice as broad as long at the base; sides rather broadly margined, subparallel and slightly rounded at the base, obliquely converging from behind the middle to the apex, all the angles acute; basal margin slightly bisinuate on either side, the median lobe broadly truncate; upper surface convex, subcylindrical in front, impressed here and there with rather coarse punctures. Scutellum wedge-shaped, its apex broadly truncate. Elytra not broader than the base of the thorax, oblong; sides parallel, moderately lobed at the base; above convex, abruptly elevated round the scutellum, coarsely punctured, the punctures piceous, placed irregularly on the anterior half of the disk, irregularly arranged in longitudinal rows on the hinder half; interspaces coarsely transversely wrinkled, those between the longitudinal striæ slightly convex.

Rhombosternus antennatus. Elongatus, angustatus, subcylindricus, piceo-fulvus, nitidus, subtus (pedibus epipleurisque exceptis) flavus; thorace sat fortiter, subcrebre punctato; elytris subfortiter, confuse punctatis, punctis ad apicem striatim dispositis; interspatiis leviter transversim rugulosis, apicem versus prope suturam longitudinaliter convexiusculis. ♀. Long. 2¼ lin.

Hab. North-western Australia.

Head rotundate; vertex and front rather closely punctured; the latter impressed between the upper portion of the eyes with a faint longitudinal groove; antennæ very slender, filiform, longer than the body, third and following joints elongate, the fourth shorter than either the third or fifth; eyes deeply notched. Thorax twice as broad as long; sides distinctly margined, rounded and cτnverging from base to apex; hinder angles acute, the anterior armed with a small lateral tooth; basal margin slightly concave on either side, its median lobe biemarginate; upper surface convex, not obliquely depressed on either side, coarsely but not very deeply punctured, interspaces very smooth and shining; basal margin narrowly edged with piceous. Scutellum

subquadrate, its apex obtusely rounded. Elytra not broader than the thorax, parallel, sides slightly lobed at the base; above convex, slightly thickened near the scutellum, rather strongly punctured, the punctures arranged towards the apex in ill-defined longitudinal rows; interspaces transversely wrinkled, those near the apex longitudinally thickened. Prosternum narrow in front, concave on the sides, dilated posteriorly, the hinder apex obtusely angled.

Rhombosternus gracilicornis. Elongatus, subcylindricus, flavus, nitidus; supra pallide piceus, thoracis marginibus scutelloque flavis; antennis gracillimis, corpore multo longioribus; thorace rugoso-punctato, disco plagâ nigrâ, antice bifurcatâ, ornato; elytris rude punctatis, punctis pone medium striatim dispositis; interspatiis crasse transversim reticulatis, inter strias longitudinaliter costatis. ♀. Long. 3 lin.

Fœm. thoracis plagâ nigrâ obsoletâ.

Hab. Western Australia.

Head rotundate, rugose; eyes deeply notched; antennæ very slender, much longer than the body, the basal joint thickened, the second very short, the third and following ones elongate, the fourth rather shorter than either the third or fifth, these latter equal. Thorax more than twice as broad as long; sides broadly margined, rounded, converging towards the apex, the anterior angle armed with a short subacute lateral tooth; basal margin slightly oblique and faintly bisinuate on either side, median lobe broad, slightly concave; above convex, obliquely depressed on either side behind the middle; the surface in front of the median lobe, together with the lobe itself, also depressed; surface coarsely rugose-punctate; the reflexed lateral border, a narrow line on the apical margin, and another less defined bordering the base pale yellow; at the base, just in front of the median lobe, is a small piceous patch. Scutellum broadly wedge-shaped (rather narrower in the male), its apex broadly and obtusely rounded, its basal margin narrowly edged with black; surface plane, impunctate. Elytra scarcely broader than the thorax, oblong, the sides parallel, moderately lobed, the lateral margin reflexed; above convex, thickened near the scutellum, very coarsely punctured; interspaces strongly and transversely reticulate, longitudinally costate near the apex and on the extreme lateral margin. Prosternum much longer than broad in the male, rather broader in the

female, concavely excavated on the sides, dilated posteriorly, its hinder apex obtusely angulate, its surface transversely convex.

Genus Bucharis, *Baly*.

Bucharis Chapuisii. Breviter ovatus, pube adpressâ griseâ vestitus, supra cupreus, subtus obscure æneo-niger; labro, antennarum articulis quinque basalibus, femoribus anticis, tibiis anticis (basi exceptis) femoribusque intermediis basi et subtus fulvis; thorace sat fortiter punctato, interstitiis minute granulosis; elytris glabris, distincte punctato-striatis; interspatiis minute et irregulariter strigosis planis, externis convexis. Long. 1–$1\frac{1}{3}$ lin.

Hab. South Australia (Gawler Town, collected by Mr. Odewahn).

Eyes large, deeply notched, moderately distant in the female, more closely approximating in the male, front between the eyes longitudinally sulcate; five outer joints of antennæ black or nigro-piceous. Thorax twice as broad as long at the base, sides rounded and converging from base to apex; basal margin bisinuate on either side, basal lobe entire, subacute, covering the base of the scutellum; upper surface sparingly clothed with adpressed griseous hairs; distinctly but not very closely punctured, the punctures oblong; interspaces (seen under a lens) very finely granulose-punctate. Scutellum oblong, its apex subacute. Elytra glabrous, finely but distinctly punctate-striate; interspaces finely and irregularly strigose, plane, two outer ones convex. Pygidium rugose, densely clothed with adpressed hairs.

Bucharis granulosus. Oblongus, supra cupreus, subopacus; labro, mandibulis antennisque basi fulvis, his extrorsum nigropiceis; subtus nigro-æneus, nitidus, pedibus cupreis; thorace granuloso, sat crebre punctato, pube adpressâ griseâ vestito; elytris granuloso-strigosis, distincte punctato-striatis, interspatiis planis, externis convexiusculis. Long. $1\frac{1}{3}$ lin.

Hab. Western Australia, Champion Bay.

Head clothed with adpressed whitish hairs, granulose, finely punctured, face impressed with a longitudinal groove between the eyes, the latter moderately distant; seven lower joints of antennæ fulvous, the rest pitchy black. Thorax twice as broad as long at the base; sides obliquely converging and moderately rounded from base to apex; basal lobe slightly reflexed, its apex obtuse; upper surface sparingly clothed with adpressed hairs, minutely granulose, rather closely covered with deeply-impressed

oblong punctures. Scutellum oblong, its apex obtuse; surface shining, impunctate. Elytra as broad at the base as the thorax, slightly narrowed towards the apex; above convex, closely granulose-strigose, opake, the suture and the lateral margin smooth and shining; surface regularly and distinctly punctate-striate; interspaces plane, those on the outer disk moderately convex. Under surface nitidous, clothed with adpressed white hairs, front surface of anterior thighs rufo-piceous.

Bucharis martius. *Ditropidus martius*, Suffr. MS. Oblongus, niger, nitidus; pedibus, capite (antennis extrorsum oculisque exceptis) thoraceque rufis, hoc convexo, fere impunctato; elytris tenuiter punctato-striatis, striis prope marginem exteriorem magis fortiter impressis, interspatiis planis, externis convexis. Long. 1 lin.

Hab. Moreton Bay.

Face faintly rugose-punctate; eyes black, remote; clypeus short, transverse, separated from the face by an indistinct transverse groove; labrum large, its anterior border obsoletely emarginate; jaws prominent, stained with piceous; five lower joints of antennæ obscure fulvous, the rest nigro-piceous. Thorax very convex, smooth and shining, nearly impunctate, only a few fine punctures being visible under a strong lens; basal lobe strongly produced, its apex entire, obtuse, covering the base of the scutellum. Elytra regularly punctate-striate, interspaces plane, those on the outer border convex. Metasternum, together with the apex of the abdomen, stained with rufo-piceous, lateral margin of prosternum piceous.

Genus Polyachus, *Chapuis*.

Polyachus marginicollis. Anguste oblongus, obscure fulvus, nitidus; supra cupreo-æneus; clypeo, labro antennisque basi fulvis, his extrorsum nigris; thorace fortiter punctato, utrinque ante basin oblique excavato, lateribus fulvis; elytris sordide fulvis, punctato-striatis, interspatiis fere planis, ad apicem et prope marginem exteriorem convexiusculis; subtus niger, tibiis, tarsis femoribusque anticis quatuor fulvis. Long. 1 lin.

Hab. Western Australia, Swan River.

Head minutely granulose; eyes distant; antennæ with the four lower joints obscure fulvous, the following three nigro-piceous, the four upper ones black. Thorax twice as broad at

the base as long, sides rounded, moderately converging from base to apex; basal lobe obtuse, its extreme apex recurved; upper surface obliquely depressed on outer side just before the base, strongly and rather closely punctured, interspaces minutely granulose-punctate; lateral margin broadly edged with obscure fulvous. Elytra oblong, scarcely broader than the thorax, fulvous, suture narrowly edged with piceous; surface distinctly punctate-striate, interspaces faintly wrinkled, nearly plane, slightly convex towards the apex and on the outer side. Beneath black, clothed with coarse, adpressed white hairs; tibiæ, tarsi, and four anterior thighs, together with the apices of the hinder pair, obscure fulvous.

Genus DITROPIDUS, *Erichs.*

DITROPIDUS PHALACROIDES. Rotundato-ovatus, postice paulo attenuatus, valde convexus, niger, nitidus, supra (antennis exceptis) obscure nigro-æneus; capite thoraceque granulosis, hoc parce tenuiter aciculato-punctato; elytris tenuiter punctato-striatis, punctis aciculatis, interspatiis planis, iis ad latera convexiusculis. Long. $\frac{1}{2}$–$\frac{2}{3}$ lin.

Hab. South Australia, Gawler Town.

Vertex and front plane, sparingly clothed with short silvery hairs, very finely granulose, impressed with a few minute punctures, visible only under a strong lens; eyes moderately distant, angularly notched; antennæ shorter than the head and thorax, the basal joint obscure rufous, the rest shining black; five outer joints broader than long, forming a distinct club; third to the sixth short, cylindrical. Thorax nearly three times as broad as long at the base; sides quickly converging and slightly rounded from base to apex, the hinder angle produced posteriorly, acute; upper surface minutely granulose, rather sparingly impressed with very fine aciculate punctures. Scutellum narrowly wedge-shaped. Elytra very finely punctate-striate, the punctures aciculate; interspaces plane, each impressed with an irregular row of very minute punctures, two outer interspaces slightly convex.

DITROPIDUS LÆTUS. Anguste oblongo-ovatus, convexus, cupreus, nitidus, subtus obscure nigro-æneus; labro, pedibus antennisque fulvis, his extrorsum nigris; thorace subremote punctato; elytris sat fortiter punctato-striatis, punctis oblongis; interspatiis ad apicem convexiusculis, externis convexis. Long. $\frac{3}{4}$ lin.

Hab. South Australia.

Vertex and front clothed with scattered whitish hairs, sparingly but distinctly punctured, the latter impressed with a longitudinal groove; clypeus transverse, semilunate, its anterior margin concave, its surface irregular, deeply but remotely punctured; eyes moderately distant, slightly notched; antennæ rather longer than the head and thorax, five outer joints moderately dilated, not longer than broad, black, the six lower ones obscure fulvous. Thorax about twice as broad as long at the base; sides rounded and converging from base to apex, more quickly converging in front; surface subremotely punctured, the punctures oblong, coarse and strongly impressed on the sides, finer on the disk; interspaces near the lateral margin faintly strigose. Scutellum ovate, its apex acute. Elytra oblong, strongly punctate-striate, punctures oblong; interspaces plane, slightly convex towards the apex, those on the outer side convex for their whole length. Body beneath clothed with whitish hairs.

Ditropidus costipennis. Breviter ovatus, niger, nitidus; labro antennarumque basi piceis; thorace fortiter punctato, interstitiis strigosis; elytris infra basin transversim excavatis, sat profunde punctato-striatis, interspatiis nitidis, pone medium obsolete transversim striolatis, convexis, ad apicem et ad marginem exteriorem costatis. Long. 2 lin.

Hab. Western Australia, Champion Bay.

Head finely punctured, subopake, space between the eyes broad, faintly impressed in the middle with a longitudinal groove; six lower joints of antennæ obscure piceo-fulvous, the upper surface of the basal joint, together with nearly the whole of the sixth, stained with piceous, seventh to the eleventh black; labrum and mandibles piceous, base of the latter rufous. Thorax convex; sides rounded and converging from base to apex; basal border bisinuate on either side, basal lobe slightly reflexed, its extreme apex narrowly but distinctly notched; upper surface convex, impressed just in front of the basal lobe with a short transverse excavation; strongly and rather closely punctured, punctures oblong, interspaces strigose; strigæ crowded at the sides, less visible and sometimes nearly obsolete on the middle disk. Elytra transversely excavated below the basilar space (the latter slightly elevated), strongly and deeply punctate-striate, the striæ sulcate; interspaces thickened, convex, costate towards the apex and on the outer disk.

Ditropidus facialis. Breviter ovatus, niger, nitidus; labro, pedibus antennisque fulvis, his apice fuscis, femoribus posticis piceis; thorace tenuiter, subremote punctato; elytris tenuiter sed distincte punctato-striatis, interspatiis impunctatis, planis, iis ad marginem exteriorem leviter convexiusculis.

Mas facie testaceâ, vertice nigro-piceo.

Fœm facie nigro-piceâ, clypeo maculâque frontali testaceis. Long. 1 lin.

Hab. South Australia, Gawler Town.

Head slightly convex, smooth, impressed with shallow punctures, sparingly clothed with fine adpressed hairs; eyes large, widely separated in the female, rather more approximate in the male; four outer joints of antennæ more or less stained with fuscous. Thorax twice as broad as long; sides rounded and converging from base to apex; upper surface minutely and subremotely punctured. Elytra finely punctate-striate, interspaces plane, smooth and impunctate, those on the outer margin very faintly convex. Beneath black, sparingly clothed with adpressed hairs; a patch on either side of the anterior margin of the mesosternum fulvous. Legs in the female stained with piceous.

Ditropidus Jansoni. Breviter ovatus, niger, nitidus; labro antennarumque basi fulvis, pedibus elytrisque chalybeis, his sat fortiter punctato-striatis, interspatiis planis, externis convexis; capite æneo, thorace nigro-æneo, sat crebre punctato.

Mas oculis approximatis, fronte angustissimo. Long. $1\frac{1}{2}$ lin.

Hab. Queensland, Rockhampton.

Head clothed with adpressed whitish hairs, brassy green; labrum and four lower joints of antennæ fulvous, the remaining joints black; eyes large, occupying nearly the whole front in the male, the space between them in that sex being almost linear; more distantly placed in the female; clypeus rugose-punctate. Thorax convex, nigro-æneous, rather coarsely and rather closely punctured. Scutellum hastate. Elytra rather strongly punctate-striate, interspaces plane, remotely impressed with fine punctures, those on the outer margin convex.

Ditropidus semicircularis, *Suffr.* MS. Breviter ovatus, cæruleo-niger, nitidus, griseo-sericeus; labro fulvo, clypei margine antico antennisque rufo-piceis, his apice infuscatis; thorace æneo vix micante, subcrebre punctato; elytris distincte punctato-striatis

interspatiis subcrebro punctatis, internis ad apicem, externis totis convexiusculis; chalybeis, utrinque fasciâ latâ curvatâ prope medium positâ, antrorsum ramulos duos emittente, fulvâ; femoribus anticis basi tarsisque piceis. Long. 2 lin.

Hab. Australia.

Head finely but not closely punctured, front broad, longitudinally depressed between the eyes, the latter widely separated; antennæ shorter than the head and thorax, rufo-piceous, stained on the outer half with fuscous; clypeus obliquely deflexed, faintly rugose, the anterior margin rufo-piceous. Thorax clothed with adpressed whitish-coloured silky hairs, distinctly and rather closely punctured; basal lobe obliquely depressed on either side along the basal margin, the space between the two depressions forming a narrow longitudinal ridge, which extends posteriorly to the apex of the lobe. Scutellum glabrous. Elytra clothed with sericeous hairs, rather finer and less abundant than those on the thorax, firmly but distinctly punctate-striate.

DITROPIDUS ORNATUS. Breviter ovatus, niger, nitidus; labro antennisque basi obscure fulvis; thorace fortiter punctato; elytris tenuiter punctato-striatis, flavis, utrinque vittâ suturali, margine exteriori, antice obsoletâ, plagâ transversâ basi ad fixâ alteraque trigonatâ pone medium positâ, sæpe ad suturam connexâ, nigris. Long. $1\frac{3}{4}$–$2\frac{1}{4}$ lin.

Hab. Western Australia.

Head clothed with adpressed whitish hairs, strongly punctured, face between the eyes concave, impressed with a faint longitudinal groove; eyes moderately distant in the male, more widely separated in the female; five lower joints obscure fulvous, more or less stained above with piceous, sixth joint entirely piceous, the rest black. Thorax convex; sides rounded and converging from base to apex, anterior angles slightly produced, acute; basal margin bisinuate on either side, basal lobe very slightly deflexed; surface smooth and shining, coarsely but not very closely punctured, punctures oblong. Scutellum ovate, its apex acute. Elytra very finely punctate-striate, punctures piceous, those on the striæ near the outer margin more strongly impressed; interspaces plane, smooth, impunctate, very slightly convex on the outer disk; bright flavous, a sutural vitta, dilated in the middle, the outer border from below the lateral lobe to the apex, a transverse patch on the middle of the basal margin, the margin itself between the patch

and the suture, and lastly a triangular patch just below the middle of the disk, usually attached to the sutural vitta, black. Front anterior thighs in the male with a piceous patch.

Ditropidus pulchellus. Breviter ovatus, niger, nitidus; capite thoraceque rufo-fulvis, illo oculis, vertice utrinque antennisque extrorsum nigris; hoc sat fortiter punctato, margine basali nigro; elytris distincte punctato-striatis, interspatiis planis, externis vix convexiusculis; utrinque fasciâ transversâ ante medium intus abbreviatâ, extus ramulum fere ad basin emittente maculâque semilunatâ ante apicem positis, læte fulvis ornatis. Long. 2 lin.

Hab. South Australia, Adelaide.

Head distinctly punctured; jaws, eyes, and an oblique patch on either side of the vertex black; face excavated between the eyes, the latter widely separated; five lower joints of antennæ fulvous, the rest piceous. Thorax nitidous, bright rufo-fulvous, the basal margin edged with black; surface rather coarsely but not closely punctured. Elytra distinctly but not strongly punctate-striate: interspaces plane, impunctate, very faintly wrinkled, those on the outer margin very slightly convex; third stria from the suture sulcate towards the apex; extreme apex of elytra coarsely punctured; each elytron with a transverse band, abbreviated at the suture, irregularly sinuate on both its anterior and posterior borders, the outer portion of the former dilated and produced upwards along the outer border of the elytron nearly to the base, and lastly a semilunate subapical patch, fulvous. Beneath black, the prothorax, together with the basal portion of the anterior pair of thighs, fulvous.

Ditropidus serenus. Breviter ovatus, postice attenuatus, convexus, fulvo-piceus, nitidus, antennis pedibusque pallidioribus; pectore, abdomine, scutello, thoracis margine basali elytrorumque lineâ suturali nigris; thorace lævi; elytris tenuiter punctato-striatis, striis ad marginem lateralem magis fortiter punctatis, leviter sulcatis; interspatiis planis, lævibus, iis ad latera convexiusculis. Long. $1\frac{2}{3}$ lin.

Hab. South Australia.

Vertex and front smooth, subremotely but not deeply punctured; eyes large, black, broadly separated in the female, less distant in the other sex: antennæ slender, rather longer than the head and thorax, five outer joints compressed and slightly dilated, third, fourth, and fifth equal in length. Thorax twice as broad at

the base as long; sides rounded and converging from base to apex, hinder angles produced posteriorly, acute; basal margin bisinuate on either side, median lobe acute, its apex finely notched; above convex, smooth and shining, rather remotely impressed with minute punctures only visible under a lens. Scutellum ovate, acuminate at base and apex. Elytra finely punctate-striate, the striæ on the outer margin rather more strongly punctured and slightly sulcate; interspaces plane, impunctate, those on the outer margin convex. Pygidium rugose-punctate, sparingly clothed with adpressed hairs. Prosternum rather longer than broad in the male; in the female slightly transverse.

Family EUMOLPIDÆ.

Genus TERILLUS, *Chap.*

TERILLUS FOVEOLATUS. Elongatus, convexus, cupreus, nitidus; pedibus antennisque fulvis, harum articulo ultimo nigro, labro flavo; capite thoraceque crebre punctatis; elytris oblongis, convexis, foveis magnis numerosis, seriatim dispositis, leviter impressis, fundo rugoso-punctatis et parce sericeis, instructis; interspatiis nitidis, hic illic inter se reticulatis, ad apicem costatis. Long. $3\frac{1}{2}$ lin.

Hab. Western Australia; a single specimen in my cabinet, collected by Mr. Duboulay.

Head closely rugose-punctate; clypeus not separated from the upper face, its anterior border narrowly edged with metallic green, bidentate; labrum and jaws pale yellow; antennæ nearly three fourths the length of the body, slender, filiform, fulvous, the apical joint black. Thorax twice as broad as long; sides rounded and converging from base to apex; above subcylindrical, closely rugose-punctate. Scutellum broader than long, sides diverging from the base towards the apex, the latter obtusely angulate; surface closely punctured. Elytra oblong, slightly attenuated at the apex, convex, covered with large shallow foveæ, arranged on each elytron in ten longitudinal rows; surfaces of these foveæ rugose-punctate and sparingly clothed with scale-like sericeous hairs; towards the apex of the elytra and on the extreme lateral border the foveæ forming each row are more or less confluent, and run into distinct longitudinal grooves; interspaces nitidous, coarsely wrinkled and irregularly reticulating on the anterior two thirds of the disk; on the hinder third and on the outer border they form longitudinal costæ.

Terillus squamosus. Elongatus, cylindricus, niger, nitidus, dense albido squamosus; labro antennisque piceo-fulvis, his extrorsum, tibiis tarsisque anticis piceis; thorace subremote punctato; elytris sat fortiter punctatis, interspatiis transversim rugulosis. Long. $3\frac{1}{2}$ lin.

Hab. Western Australia, Nichol Bay.

Body densely clothed with adpressed white scales. Head rather strongly but not very closely punctured, clothed with long slender adpressed white scales; eyes prominent, rotundate-ovate, slightly sinuate; antennæ slender, more than half the length of the body, second joint short, obovate, the third and fourth each twice as long as the second, equal, the fifth and sixth rather longer, also equal. Thorax twice as broad as long; sides rounded and diverging at the base, thence obliquely converging to the apex, slightly sinuate just behind the middle; above subcylindrical, excavated on the basal margin just in front of the scutellum, impressed, but not very closely, with deep round punctures, clothed with similar scales to those on the head. Scutellum broader than long, its apex broadly rounded. Elytra broader than the thorax, parallel, subacutely rounded at the apex, dehiscent at the sutural angle; above cylindrical, coarsely punctured, the interspaces transversely rugulose; surface clothed with elongate-ovate, very acuminate scales; besides these, scattered here and there, are a few very long, slender, thread-like, erect hairs. Body beneath and legs densely clothed with linear scales.

Terillus perplexus. Elongatus, subcylindricus, pube adpressâ squameiformi albidâ dense vestitus; subtus piceus, pedibus abdomineque pallidioribus; supra cupreus, labro antennisque fulvis, harum articulis ultimis apice infuscatis; thorace tenuiter, subremote punctato; elytris subcrebre punctatis, interspatiis transversim rugulosis. Long. $2\frac{1}{2}$ lin.

Hab. Western Australia, Nichol Bay.

Body densely clothed with linear, adpressed, scale-like hairs. Head exserted, vertex and front remotely and finely punctured, impressed in the middle with a shallow longitudinal groove; clypeus rather more strongly punctured than the upper face; antennæ more than half the length of the body, slender, entirely filiform, fulvous, the apices of the five or six outer joints stained with fuscous; eyes ovate-rotundate, entire. Thorax twice as broad as long; sides regularly rounded; above convex, nitidous,

finely and remotely punctured. Scutellum transverse its apex broadly and obtusely rounded. Elytra broader than the thorax, oblong, parallel; above convex, rather closely punctured, interspaces transversely rugulose.

Terillus Duboulayi. Subelongatus, subcylindricus, obscure æneus, dense albido-squamosus; labro, antennis pedibusque rufo-piceis; thorace subcylindrico, sat remote, mediocriter punctato; elytris tenuiter punctatis, interspatiis ante medium transversim rugulosis. Long. 3 lin.

Hab. Western Australia.

Body densely clothed with adpressed scales. Head exserted, broad, distinctly but not strongly punctured, surface closely covered with long, white, adpressed scales; clypeus broader than long, sides converging towards the apex, the apical border obsolete; eyes large, remote, prominent, subrotundate, their inner border slightly sinuate; antennæ not half the length of the body, slender; jaws black. Thorax nearly twice as broad as long; sides nearly parallel behind the middle, slightly converging in front; above subcylindrical, subremotely punctured, densely clothed with adpressed scales, a longitudinal space down the centre of the disk, and another, less defined, on either side, nearly glabrous. Scutellum much broader than long, its sides diverging from the base towards the apex, the latter broadly and obtusely rounded. Elytra scarcely broader than the thorax, their sides parallel, their apices conjointly, subacutely rounded; above subcylindrical, irregularly punctured; interspaces on the anterior disk transversely rugulose; surface closely covered with white and pale fuscous scales, arranged in broad, ill-defined vittæ, leaving on each elytron three or four nearly glabrous longitudinal spaces.

Terillus vittatus. Elongatus, convexus, cupreus, nitidus, pube subdepressâ griseâ vestitus; antennis, tibiis tarsisque piceis; thorace rugoso-punctato, utrinque excavato, disci medio maculâ trifidâ, et ante medium serie transversâ punctorum nitidorum instructo; elytris rude punctatis, utrinque infra basin fovea magna excavatis, interspatiis transversim elevato-strigosis, vittis nonnullis interruptis, prope apicem magis elevatis, instructis. Long. 2½ lin.

Hab. Queensland, Rockhampton.

Head rugose-punctate, clothed with long, subdepressed, silky hairs; clypeus wedge-shaped, less closely punctured than the

upper part of the face; eyes prominent, subrotundate, distinctly notched; antennæ half the length of the body, filiform, six lower joints pale piceous, the five outer ones nigro-piceous. Thorax about one half broader than long; sides rounded, converging in front; above convex, coarsely punctured, rugose, impressed on either side with a large deep fovea; on the middle of the disk is a slightly raised, ill-defined, smooth and shining trifid patch, and in front of this are six small, shining, impunctate spots, arranged in a transverse curve. Scutellum broader than long, its apex broadly rounded, its surface glabrous, finely but not closely punctured. Elytra broader than the thorax, oblong, attenuated at the apex, the latter conjointly subangulate; above convex, coarsely and closely punctured; interspaces irregularly thickened, transversely strigose on the anterior disk; on each elytron are four or five raised, smooth and shining vittæ, only slightly elevated and ill-defined on the anterior disk, interrupted towards the apex and forming short, strongly-raised ridges; on each elytron below the basilar space is a large deeply-excavated fovea.

Genus Geloptera, *Baly*.

Geloptera igneo-nitens. Oblonga, convexa, subtus picea, æneo-tincta; supra ænea, rufo-aureo tincta, antennis nigris, basi piceis; thorace crasse, irregulariter punctato, lateribus tridentatis; elytris sat profunde confuse punctatis, punctis ad apicem minus fortiter impressis; interspatiis transversim rugosis, apicem versus magis elevatis et longitudinaliter subcostatis. Long. $3\frac{3}{4}$–5 lin.

Hab. Western Australia.

Head cupreo-igneous, rugose-punctate, front impressed with a fine longitudinal groove; clypeus wedge-shaped, well defined, its surface less closely and less coarsely punctured than the rest of the head; antennæ equal to the body in length in the male, shorter in the female, filiform, not thickened towards the apex, third and fourth joints each twice the length of the second, equal; four lower joints piceous, the rest black. Thorax more than twice as broad as long; sides rounded, tridentate, the anterior border narrowly, the hinder one broadly margined; above convex, coarsely and irregularly punctured, the punctures less crowded on the disk; whole surface deeply tinted with coppery red. Scutellum semioblong-ovate. Elytra broadly oblong, much broader than the thorax, coarsely and irregularly punctured, the punctures

towards the apex finer and much less strongly impressed; interspaces transversely wrinkled, more strongly thickened near the apex, and there forming raised longitudinal rows.

Geloptera vestita. Ovata, valde convexa, picea, nitida, pube adpressa grisea vestita, pedibus antennisque pallidis harum articulo ultimo nigro; thorace transverso, inde punctato, lateribus tridentatis; elytris crasse punctatis, punctis ad apicem striatim dispositis, interstitiis subcostatis. Long. 3 lin.

Hab. Port Bowen.

Head closely and coarsely punctured; front concave between the eyes; clypeus trigonate; antennæ slender, three fourths the length of the body, third joint three times the length of the second, the eleventh joint black. Thorax twice as broad as long; sides rounded, armed with three stout acute teeth; above transversely convex, coarsely punctured. Elytra much broader than the thorax, convex, coarsely punctured, the punctures towards the apex arranged in longitudinal rows; interspaces between these rows subcostate; on the anterior disk are also several slightly raised costæ.

Genus Rhyparida, *Baly*.

Rhyparida maculicollis. Oblongo-ovata, convexa, piceo-nigra, nitida, supra rufo-castanea, antennis (basi excepta), thoracis maculis duabus, transversim positis, elytrorumque plaga magna communi a basi fere ad apicem extensa, postice attenuata, nigra. Long. $2\frac{2}{3}$ lin.

Hab. Queensland, Rockhampton.

Clypeus coarsely punctured, not distinctly separated from the face, its anterior border deeply concave-emarginate; vertex nearly impunctate; front faintly impressed with a longitudinal groove; antennæ with the three lower joints rufo-fulvous, the fourth piceous, the rest black; third joint one third longer than the second. Thorax nearly twice as broad as long; sides rounded, converging in front; anterior angles armed with a small obtuse tooth; above convex, smooth and shining, remotely impressed with minute punctures, only visible under a lens; placed transversely on the disk, but rather nearer the anterior border than the base, are two large black patches. Scutellum semirotundate-ovate, piceous. Elytra broader than the thorax, oblong, convex, faintly excavated below the basilar space, regularly punctate-striate, the punctures coarser and more deeply

impressed on the anterior disk, finer behind the middle; interspaces plane, very remotely impressed with minute punctures, only seen under a lens. Body beneath shining nigro-piceous, the claws pale piceous. Hinder thighs armed beneath with a minute tooth.

Family CHRYSOMELIDÆ.

Genus Cyclonoda.

Corpus late ovato-rotundatum, valde convexum, apterum. *Caput* in thoracem insertum; *oculis* angustatis, elongatis, remotis; *antennis* corporis dimidio brevioribus, ad apicem vix incrassatis; *clypeo* ♂ profunde et oblique incisa, ♀ semper transversim truncato; *palporum* maxillarium articulo ultimo ovato. *Thorax* transversus. *Scutellum* trigonatum. *Elytra* convexa, regulariter punctato-striata, lateribus ante medium modice lobatis, limbo inflexo horizontali, plano. *Pedes* robusti; *unguiculis* inermibus. *Prosternum* canaliculatum, antice in processum obtusum breviter productum; *acetabulis* anticis apertis.

Type *Cyclonoda pilula*, Clark (*Chalcomela*).

The present genus is separated from *Chalcomela* by its apterous body, closely united elytra, and by the distant, narrow, and elongate eyes. The males are distinguished by the remarkable forms of the clypeus: in *C. pilula* and *subpunctata* of Clark (the only species in which the male is known to me) the anterior border of the clypeus is obliquely incised by a broad angular notch, commencing close to the insertion of the right antenna, and extending more than halfway across the segment; the lower margin of the notch is developed into an obtuse lobe, thickened at the base, and produced obliquely forward, concealing (when viewed from above) the greater portion of the labrum.

Genus Paralepta.

Corpus elongatum, parallelum, convexum. *Caput* exsertum; *oculis* remotis, prominulis, elongato-ovalibus; *antennis* filiformibus, corporis dimidio æqualibus; *palpis* maxillaribus articulo ultimo trigonato, apice late truncato. *Thorax* transversus, lateribus irregulariter crenulatis. *Scutellum* trigonatum. *Elytra* thoraci æquilata, parallela, confuse striatim punctata. *Pedes* mediocres; *unguiculis* acute appendiculatis. *Prosternum* mesosterno æquilatum, apice vix ampliatum, dorso canaliculatum; *aceta-*

bulis anticis apertis. *Mesosternum* transversum. *Metasternum* apice immarginato, lateribus linea impressa instructis.

Type *Paralepta foveicollis*.

This genus is intermediate between *Calomela*, Hope (*Australica*, Chevr.), and *Carystea*, mihi: in the toothed claw it agrees with the former; in the narrow elongate form and in the emarginate apex of the metasternum with the latter; it differs from both in the crenulate lateral border of the thorax.

Paralepta foveicollis. Elongata, parallela, subcylindrica, nitida, subtus obscure nigro-æenea; supra obscure viridi-æenea, cupreo-violaceo nitens, antennis (basi piceo excepto) nigris; thorace modice convexo, ad latera dense, disco minus crebre, foveolato-punctato, interspatiis rude elevato-reticulatis; lateribus irregulariter sed leviter crenulatis; elytris sat crebre striatim punctatis, interspatiis leviter rugulosis, ad apicem leviter vittatis. Long. 4–5 lin.

Hab. New South Wales.

Head closely rugose-punctate; antennæ slender, four lower joints obscure piceous, the rest black. Thorax twice as broad as long; sides straight and nearly parallel from their base to beyond the middle, thence rounded and converging to the apex, the anterior angle slightly produced, acute; lateral margin irregularly crenulate *; upper surface moderately convex, closely covered on the sides, more distantly so on the middle disk, with large, deep, foveolate punctures; interspaces nitidous, elevate-reticulate; disk with several distinctly raised, irregular, impunctate patches. Elytra scarcely broader than the thorax, parallel; above convex, very slightly excavated below the base, aciculate-punctate, the punctures closely arranged in longitudinal rows, those on the inner disk geminate; interspaces rugulose, transversely strigose before the middle, elevated into faint vittæ towards the apex.

Family GALLERUCIDÆ.

Subfamily Halticinæ.

Genus Platycepha.

Corpus elongato-ovatum, convexum. *Caput* subtrigonatum, inter oculos planum; *antennis* ad caput cum thorace vix æqui-

* These crenulations vary in degree, and are occasionally almost entirely wanting.

longis, extrorsum paulo incrassatis, articulis 8°–10° subturbinatis, ultimo rotundato-ovato; *oculis* remotis, ovalibus, integris; *carina* et *encarpis* obsoletis. *Thorax* transversus, transversim convexus. *Elytra* anguste oblongis, parallelis, thorace vix latiora, modice convexa, punctato-striata. *Pedes* breves, robusti; *coxis* anticis prosterno æquialtis; *femoribus* anticis quatuor modice, posticis valde incrassatis; *tibiis* a basi ad apicem incrassatis, apice spina acuta armatis; dorso profunde canaliculatis, sulci marginibus vix ante apicem dente acuto armatis. *Tarsis* posticis apici tibiarum insertis; *unguiculis* appendiculatis. *Prosternum* planum, apice dilatatum; *acetabulis* anticis integris.

The extremely short antennæ, the short robust legs, the flattened face between the eyes, together with the absence of any thoracic grooves, will separate *Platycepha* from any allied genus.

Platycepha eximia. Elongato-ovata, convexa, flava, nitida, scutello, antennis extrorsum femoribusque posticis apice fusco-piceis; capite (antennis exceptis) pallide rufo-piceo; thorace fulvo, tenuiter punctato; elytris nigris, margine laterali ante medium anguste rufo; sat fortiter punctato-striatis, interspatiis planis, leviter ruguloso-punctatis.

Var. A. elytris fusco-piceis, margine externo late flavo. Long. 2 lin.

Hab. Western Australia, Nichol Bay.

Head smooth, nearly free from punctures; surface flat, carina and encarpæ entirely obsolete, the interocular spaces being only indicated by a faint line on the upper margin; labrum flavous; antennæ with the six lower joints flavous, the rest fuscous; basal joint moderately, the second slightly thickened, second and five following joints nearly equal in length, the fifth to the seventh gradually increasing in width, slightly flattened, trigonate, the eighth to the tenth very slightly compressed, subturbinate, the eleventh rotundate-ovate; eyes remote, shining black. Thorax nearly twice as broad at the base as long; sides rounded and diverging at the extreme base, thence obliquely converging to the apex, anterior angles slightly produced, very obtuse, the hinder ones nearly obsolete; upper surface minutely and distinctly punctured, the puncturing only visible under a lens. Scutellum broader than long, its apex broadly rounded. Elytra oblong, moderately convex, distinctly punctate-striate, interspaces finely

rugulose and finely punctured. Tibiæ stout, increasing in thickness from base to apex, their outer surfaces broadly grooved, margins of the groove in the four hinder tibiæ each armed just before the apex with an acute tooth; outer border of the groove on the front pair armed with a similar tooth; hinder tibia equal in length to the femur.

Genus Arsipoda, *Erichs.*

Arsipoda piceipes. Elongato-ovata, convexa, cuprea, nitida, pedibus piceis; antennis corporis dimidio vix brevioribus, ad apicem incrassatis, nigris, basi piceis; thorace crebre punctato, basi utrinque sulco brevi perpendiculari impresso; elytris tenuiter punctato-striatis, interspatiis planis, tenuissime punctatis. Long. 2 lin.

Hab. Western Australia (*Duboulay*).

Head trigonate, rugose; carina slightly raised, ill-defined, acuminate at base and apex; encarpæ ill-defined, transverse, not contiguous; front impressed on either side with a deep groove, which runs obliquely upwards along the inner border of the eye; antennæ nearly half the length of the body, six outer joints thickened and forming an indistinct elongated club; six lower joints piceous, the rest black. Thorax rather more than twice as broad as long at the base; sides straight and parallel behind the middle, thence rounded and converging to the apex, anterior angles oblique, thickened, obtuse; basal margin faintly sinuate on either side the median lobe, the latter scarcely produced, broadly truncate; upper surface rather strongly and somewhat closely punctured; base impressed on either side, at some distance from the lateral margin, with a deep, slightly curved, perpendicular groove; in the middle between these grooves is a faint indication of a transverse groove. Scutellum trigonate. Elytra rather broader than the thorax, ovate, attenuated towards the apex, convex, finely punctate-striate, the punctures rather stronger on the basal half of the surface; interspaces plane, minutely but not closely punctured. Legs piceous; hinder thighs moderately curved, lower half of upper surface only slightly grooved.

Very similar in form to *A. consuta*, Germ.: more robust and less elongate than that insect, the antennæ shorter and much more incrassated towards their apices.

Genus Œdionychis, *Latr.*

Œdionychis Howittii. Ovata, convexa, nitida, subtus picea, pectore abdomineque piceo-fulvis; supra nigra, elytris metallico-purpureis. Long. 2 lin.

Hab. New South Wales, Sydney.

Head short; carina plane, its surface impressed with a faint longitudinal groove; clypeus abruptly inflexed, shortly semi-lunate, its surface concave; encarpæ contiguous; antennæ moderately robust, much less than half the length of the body. Thorax nearly three times as broad as long; sides reflexed, converging and slightly rounded from base to apex, the hinder angles acute, the anterior curved slightly outwards and forming an obtuse tooth; disk smooth, impunctate. Elytra broader than the thorax, very finely but not closely punctured; interspaces smooth and shining, faintly wrinkled below the base; reflexed lateral margin narrow, impressed with a single row of coarse punctures. Hinder tibia short, its outer surface armed just before the apex with a short tooth; basal joint of hinder tarsus shorter than the two following united, claw strongly inflated.

Genus Sphærophyma.

Corpus rotundatum, valde convexum. *Caput* parvum, thoraci ad oculos insertum; *oculis* magnis, elongatis, intus leviter sinuatis; *antennis* proxime insertis, thorace paulo longioribus, filiformibus, modice robustis; articulo basali elongato, paulo incrassato, leviter curvato, secundo brevi, ovato; *encarpis* subtrigonatis, contiguis; *carina* leariformi. *Thorax* transversus. *Scutellum* parvum. *Elytra* thorace multo latiora, punctato-striata, limbo inflexo dilatato, margine exteriore deorsum producto. *Pedes* breves; *coxis* anticis prosterno æquialtis; *femoribus* posticis valde incrassatis; *tibiis* anticis quatuor apice muticis; *tibiis* posticis crassis, paulo recurvatis, apice in processum acutum prolongatis, dorso plano, ante apicem spina valida subclaviformi, apice subacuta, armato; *tarsis* posticis tibiarum dorso, vix ante apicem, insertis, articulo basali cæteris longiore; *unguiculis* appendiculatis. *Prosternum* planum, postice ad metasternum productum, *acetabulis* anticis integris. *Mesosternum* occultum.

Sphærophyma, which I have established on a remarkable insect collected at Rockhampton by Mr. Simon, is nearly allied to *Argopistes*, Motsch.: it may be known from that genus by the punctate-striate elytra.

SPHÆROPHYMA SIMONI. Rotundata, valde convexa, flava, nitida, oculis nigris, femoribus posticis piceis; thorace sat crebre tenuiter punctato; elytris tenuiter punctato-striatis, punctis in striis confuse dispositis, interspatiis planis. Long. $1\frac{1}{2}$ lin.

Hab. Queensland, Rockhampton.

Eyes large, black, occupying a considerable portion of the face; antennæ nearly contiguous at their insertion, being only separated by the linear carina, which extends downwards across the large triangular clypeus, and nearly reaches the anterior border of the latter; encarpæ slightly raised, ill-defined. Thorax nearly three times as broad as long; sides very obliquely converging from base to apex, anterior angles thickened, slightly produced, very obtuse, hinder angles rounded; basal margin oblique and bisinuate on either side, the median lobe slightly produced, broadly and obtusely rounded; surface rather closely but finely punctured. Elytra much broader than the thorax, the shoulders broadly rounded; upper surface very finely punctate-striate, the punctures (in some specimens) piceous; interspaces plane, impressed with punctures equal in size to those on the striæ themselves; outer margin broadly dilated, irregularly punctured.

This insect, like the species belonging to Motschulsky's genus *Argopistes*, has quite the facies of a *Coccinella*.

Observations on British Polyzoa. By CHARLES WILLIAM PEACH, Esq., A.L.S. &c.

[Read June 7, 1877.]

(PLATE XXIII.)

SCRUPOCELLARIA scruposa.—Although this is common and well known, I am able to add a little to its history. On the 10th of June, 1876, I got a nice specimen at Newhaven, on a sponge (*Halichondria panicea*) from the Firth of Forth. From a desire to know how it moored itself to this soft body, I carefully examined it, and cut open the sponge, and found, as I thought, curious sponge-spicules, differing from all I had previously seen. On tearing the *Scrupocellaria* from the sponge, I at once saw what I took for spicules were actually the "tubulous root-fibres" of the *Scrupocellaria*; here, then, was a new fact to me. Hitherto I had always considered these "tubulous root-fibres" as smooth, with a disk, for adhesion to

any thing, at the lowest end; in this case they were armed with stout hooked spines where they were buried in the sponge, the points of the hooks bent towards the zoophyte, like the flukes of an anchor pointing towards the bow of a ship when the cable is stretched tight. These hooked spines are shaped like the thorn of a rose-tree, and surround the "root-fibres" in a rather irregular manner, and when dragged out of the sponge they hold in their grasp numbers of the sponge-spicules; this at once explained why these "root-fibres" were armed with hooks, and the points bent towards the zoophyte (see Pl. XXIII. fig. 1).

In March of the present year (1877) I got another specimen from the same locality, and found that the spines &c. were constant under similar circumstances. Feeling much interested in the discovery I resolved to follow it up, and fortunately turned up from my hoards a specimen of *Canda reptans*, collected in Cornwall before 1849; it is also attached to a sponge. On examination it shows similar *hooked spines* on the "tubular root-fibres" (fig. 2). In the hope of confirming this with a Scotch specimen I got *Canda reptans* from Newhaven, unfortunately not on a sponge, but on *Flustra foliacea*: here the hooks are absent; but the tips of the "root-fibres" are furnished with short radiating processes spread out at right angles, and from these, short disk-like processes are inserted into the openings and body of the cells of the *Flustra*, thus giving a firm grip on this larger fan-shaped and firmer support, and enabling the zoophyte to ride safely in a storm (see fig. 3).

Here, then, we have curious instances of things low (but are they low? of course I hope that you will take this by comparison only) in the scale so well adapting themselves to changed circumstances as to secure their safety and preservation. In no work on *British Zoophytes* can I find any notice of these hooks. Prof. Busk has figured, in the 'British Museum Catalogue of Marine Polyzoa,' part 1, pl. xxiv., a *Scrupocellaria Macandrei*, from the coast of Spain, and described it at page 24 as having "*Radical tubes hooked*;" and at page 25 he mentions *Scrupocellaria ferox*, from Bass's Straits, as "hooked like *S. Macandrei*." These instances, however, are not *British*. I hope to follow out this discovery when the weather becomes settled and warmer.

Eschara Skenei, var. *tridens*, Busk.—Although I have known this variety for many years, it is only a short time ago that I was aware of Professor Busk's paper in the 'Magazine of Natural

History,' 1856, in which he has figured and described the above named from Norway and Finmark, collected by the late Mr. McAndrew. In 1860 I obtained at Wick, N.B., a specimen from a fisherman's line hooked up from deep water off the Caithness coast in 30 fathoms. In the same year I got a second specimen at Latheron Wheel, from the same locality, also from a fisherman's line. I procured a few more (three or four) specimens during my residence at Wick; however, they are very rare. All of them answered to Mr. Busk's description, with one exception; this, I fancy, he suspected, for he writes "*unarmed?*" in his description. Mine are armed with *two delicate spines on the distal lip, and when viewed from the front show as if there were one on each side of the central rostrum* (see Pl. XXIII. fig. 4); and thus his note of interrogation was warranted. These spines are generally seen on the last-formed cells, rarely on the central ones; they are so very delicate, and thus easily knocked off. The common form occurs off Caithness; in fact at every part of the east coast of Scotland where I have resided. I have one much worn specimen of the variety from the Out Haaf of Shetland, dredged by Dr. Gwyn Jeffreys in 1864. This, then, is now added (for the first time I believe) to the British list.

Eschara rosacea.—This is another species described in the same paper as the above from Norway, by Prof. Busk, and was first added to the British list by the Rev. A. M. Norman, and described by him in vol. viii. of the 'Microscopical Journal,' pl. vi. figs. 10–21 ("On Stones and Shells from Loch Fyne"). I have the pleasure of recording it from a new locality, dredged off Shetland by Dr. Jeffreys in 1864, in from 80 to 100 fathoms, and recognized by myself as new. The first specimen I found I sent to the late Mr. Alder, who could make nothing of it, from its being nearly covered by two species of well-known *Lepralia*; very little of the original could be seen. Not being able to get out last year (winter of 1876–77), I amused myself by looking over sand and broken organisms, and found two more small, well-worn, but characteristic specimens, showing the cells &c. sufficiently well for identification. The specimens are all unattached. This, then, is an addition to the fauna of the east coast of Scotland.

Eschara stellata, Peach, n. sp. (Pl. XXIII. fig. 5).—This is another specimen dredged by Dr. Jeffreys in 1864 off Shetland; I noticed it at the time we were there, and fixed it on a ticket, with locality

and date; it occurred in sand amongst many fragments of *Eschara* of various kinds. Up to December last it had quite escaped my memory, when it turned up again, and was instantly recognized. So far, it is the only specimen of it I have seen, nor can I find any thing like it noticed in any work I have access to, or gain any information about it from other naturalists. I am, however, most anxious to learn all I can about it. I have provisionally named it; it is evidently a piece of an *Eschara*. It is flattened on the sides, with cells on both sides. In section the cells may be seen at the ends in two rows in the centre, separated by a thin division, the side walls of the cells resting on the centre of the body of each opposing cell; these cells are surrounded by a border of striped coral matter, as in a section of *Eschara Skenei*, &c. The cells are arranged in an irregular quincuncial manner, running obliquely all round the stem. The mouth of the cell is slightly raised, and slopes gently downwards; the border thick, with a slit-like opening in front extending a short way down the cell; it is also surrounded by buttress-like projections, and in the spaces between them are perforations, apparently open; the whole of the cells are thus surrounded, giving the specimen a stellate appearance, and thus the specific name (see sketch modified by Mr. Busk from specimen, fig. 5, forwarded him). It has a fresh appearance, like that of the other well-known *Eschara* found with it, a little abraded, but has not a semifossil look*.

Discopora meandrina, Peach, n. sp. (Pl. XXIII. figs. 6–8).—This is also from the Out Haaf, Shetland, dredged by Dr. Gwyn Jeffreys in 1864. It is generally attached to *Eschara*, especially *E. cervicornis*, rarely on stones or shells, never in an adnate manner; for when first fixed it forms a thin plane platform; this is thickened and extended as the polypidom increases, and its edge is turned upwards or downwards, spreading and accommodating itself to the rounded stem and all the sinuosities of its support, even to bending round so as almost to conceal it, leaving, however, a space between it and its support (see fig. 6, *dm*). The upper face is waved and undulating, and reminds me of a contoured map, showing the hills and valleys. It is traversed by ridges of cells, surrounding in a meandering way depressed smooth spaces like little fields; these ridges and cells and spaces give a meandering look to the whole, like the brain-coral. These little fields are

* [This is probably a variety of one of the different species confounded with the name *E. cervicornis*.—G. B.]

pitted with small hexagonal depressions. The other parts of the specimen, where the ridges run, have also these hexagonal depressions, but larger, with basin-like depressions, and at the bottom are perforated with a central opening; the ridges are also larger and higher: the mouths of the cells are much raised, with a long pointed mucro, the point often hollow and bending over a little, like the tip of the beak of a bird (fig. 7); these cells are in the centre of the ridges, and when denuded of the mucro form a chain of elongated cells (fig. 8); they are not in straight lines, but meander over the face of the specimen, accommodating themselves to the irregularities of the elevations and depressions by longer or shorter ridges.

It is pale cream-colour on the ridges, nearly white in the depressed spaces. I may remark that the mucro on the raised cells is never bifid or trifid, the rows of cells *always meandering* from its *earliest state*; nor does it rise into a dome shape, nor are the pores at the bottom stellate as in *D. hispida*. There is another peculiarity in it—that of repairing injuries and of laying a new layer of cells over the lowest series (specimen exhibited at the Society's Meeting). I have carefully examined the works of Johnston, Busk, Alder, Couch, Hincks, Smith, &c., and find nothing altogether like it; in fact the difference between it and *D. hispida* is so great that I feel justified in making it a new species. After all, should it be thought that I am wrong, I shall still consider it a good variety, and thus then it will be *D. hispida*, var. *meandrina*.

Domopora truncata, Jameson.—This is, I believe, the true *D. truncata* of Jameson and Forbes, but not of Fleming nor Busk. My specimens were brought up by the fisher's lines from about 80 to 100 fathoms, in the Out Haaf, Shetland, in 1864; they are on rather large rounded stones, and from the same locality as those got by Jameson and Forbes. Fleming describes his as "about 1 inch in height . . . the head stellate." Busk says, "Zoarium simple or lobed (proliferous); cells disposed in twelve to fourteen *elevated biserial rays* on the rounded extremity of the trunk or lobes," and in his pl. xxxi. of the 'Catalogue of Marine Polyzoa,' part iii. 1875, in several figures has shown the "proliferous" state and elevated truncate biserial rays. The figure of Forbes's specimen given in vol. ii. of the second edition of Johnston's 'British Zoophytes,' plate xxxiii. figs. 1, 2, and the description given in vol. i. p. 271, of the same work, help to confirm my

opinion; I quote only the following:—"*Tubularia truncata* has been described as *being branched*, which it *never truly is*; but two or three individuals may grow on a primary polypidum so closely together that they coalesce at the base, and dying, new corals rise from the dead individuals, and thus give the polypidum a branched or nodulous aspect . . . It is a solid coral."

Forbes's specimens were about two tenths of an inch in height, mine never more than five tenths of an inch.

The cells are all nearly of the same shape and radiate in the same manner as seen in *D. stellata*, are more polished, and altogether the walls are much thicker; in fact the polypidom is altogether so, it never rises into branch-like forms, nor do the largest cells on the upper part of the ridges become truncated. I have seen four low rounded tips side by side on the earliest base: the base is thin, and at first slightly pitted and firmly attached to the stone; it soon becomes strongly reticulated and met by a raised step-like ridge, in the vertical front of which are groups of rather large and tall cells, three or four in a group, forming a lace-like border, crenulated on the upper part, and from these crenulations spring the thirteen or fourteen rounded rib-like rows of cells which run up to near the top, where they die out and leave a slight depression. From the broad thin base and the pretty sweep the ribs take, with the rounded top, I am reminded of the round-polled hat so fashionable ever since the late Prince Albert wore a miner's "hat-cap" when with the Queen in the underground workings of the Royal Restormal Iron-Mine, at Lostwithiel, Cornwall. I may mention that this species is much rarer than the next and, as far as I have seen, found only on stones. The one figured by Forbes was also on a stone. It occurs to me that some may think that the dwarfed state, thick walls, rounded ribs, and total absence of the truncated crown of vertical cells of this species might be caused by the stones being rolled about in storms or by tides. Such, I am convinced, could not be; for in addition to the *Domopora*, I got from the same stones my finest and best examples of *Eschara cervicornis*, and most beautiful examples of *Hornera borealis*, all in a most perfect state, with every branch intact, proving tranquillity in their home.

Domopora (*Defranceia*) *stellata* (Goldf.).—This beautiful species has been confounded with the true *Domopora truncata* of Jameson, Forbes, and Fleming. It is certainly nearest to Fleming's description,

"about an inch in height . . . stem round, branched, ending with enlarged globular heads, radiated with plates of united vertical cells." Busk has well figured and described it in the 'Annals and Magazine of Natural History,' 2nd series, vol. xviii. p. 36, pl. i. fig. 9, from the coast of Norway, and in his 'Catalogue of Marine Polyzoa,' part iii. page 35, pl. xxxi. figs. 1, 2, from Shetland, as *Domopora* (*Defranceia*) *stellata*. His description is, "Zoarium simple or lobed (proliferous); cells disposed in twelve to fourteen elevated biserial rays on the rounded extremity of the trunk or lobes."

It is a variable species, at times rising as a single lobe, crowned with radiating cells on the upper part of the rounded extremity; when this crown is broken off, a funnel-shaped depression is often left, and this then forms the *Corymbipora fungiformis* of Smitt.

From this simple state it by successive growths often becomes "proliferous," and thus in appearance branched; the crowns of erect truncated cells are often destroyed, and at times side by side one tip is shorn of its crown of biserial ridges, whilst the other has its decoration perfect. To show how protean it is, I have sent a series of specimens (exhibited at the Meeting) with from one to thirteen of these star-crowned parts, and from which it so well takes its specific affix. On one of the specimens marked there is amongst the raised cells what I believe to be an *ovarian vesicle*. I have never before seen such noticed on this genus.

I also send a specimen (likewise exhibited at the Meeting) showing the internal structure, and another rubbed down and placed on glass for that purpose.

It will also be seen that some of my specimens are splendid ones, better than any I have seen figured; they give an excellent idea of the size and variety of forms it assumes, and as well how greatly it differs from the real *Domopora truncata*.

Defranceia lucernaria.—This pretty cup-shaped Polyzoon I first obtained from sand dredged by Dr. Jeffreys in the Out Haaf of Shetland in 1864. I found but one or two specimens. In 1866 I got three or four more in sand, dredged by the same gentleman on the west coast of Scotland. From the fishermen's lines at Wick, N.B., I met with one or two from about 30 fathoms. Unfortunately all are more or less rubbed, and they do not show so distinctly as could be wished the characteristic markings, so as to render it positive that they agree altogether with those figured by

Mr. Busk in part iii. of the British-Museum 'Catalogue,' pl. xxxiii. If they prove to be Sars's species they are an addition to the *British list.*

DESCRIPTION OF PLATE XXIII.

Fig. 1. *Scrupocellaria scruposa,* obtained from the Firth of Forth, 10th June, 1876, attached with hooks to the sponge *Halichondria panicea,* Johnst. *s,* sponge-spicules; *h,* hooks of the root-fibres of *S. scruposa.* Magnified.

Fig. 2. *Canda reptans.* A small portion collected in Cornwall in 1848, and in which I detected the hooks attaching it to a sponge, 14th March, 1877. Also considerably enlarged.

Fig. 3. A fragment of *C. reptans* on *Flustra foliacea* (*f*), Firth of Forth, March 1877. Hooks absent, but grappling-roots (*gr*) present. Magnified.

Fig. 4. A small portion of *Eschara Skenei,* var. *tridens,* Busk, obtained off Wick (N.B.), 1st March, 1864. Greatly magnified.

Fig. 5. *Eschara stellata,* Peach, n. sp. Specimen dredged by Dr. J. Gwyn Jeffreys at Shetland, 1864. Sketch partly from specimen, a drawing of my own, and from an old original one by Mr. Busk.

Fig. 6. *Discopora meandrina,* Peach, n. sp. Obtained from fishermen's lines in Shetland, 1864, from a depth of 80 to 100 fathoms. The examples (*dm*) of this species shown in the specimen are attached to a piece of dead coral, and are enlarged about 3 times nat. size.

Fig. 7. A highly magnified profile view of some of the cells of *D. meandrina,* showing the elongated beak-like mucro.

Fig. 8. A view from above of a chain of the open-mouthed cells of the foregoing specimen, also much enlarged.

Contributions to the Ornithology of New Guinea. By R. Bowdler Sharpe, F.L.S. &c.—Part. IV. On the Collection of Birds brought by Mr. Octavius C. Stone from South-eastern New Guinea.

[Read June 21, 1877.]

The collection which Mr. Stone brought with him from New Guinea is probably one of the largest that has yet been made in the southern part of that great island; but, as in the case of the late Dr. James's consignments, the novelties found in it are very few in number; and it becomes more and more evident that South-eastern New Guinea cannot compare with the northern portion of the island as regards the richness of its avifauna.

Mr. Stone informs me that the collection now about to be described was formed by Messrs. Broadbent and Petterd, two well-known and experienced naturalists, and it is to this circumstance that the excellent preservation of the skins is due; but one misses

greatly the particulars of sex, locality, and date which were appended to Dr. James's specimens, and which are always of the greatest importance in the preparation of a collection of birds. Mr. Petterd supplied Mr. Stone with a MS. list of birds, giving the localities where they were collected; and it is from this list that the places have been inserted in the present paper. In some few instances the names of birds occur in Mr. Petterd's list which were not in the collection; but where there can be no doubt as to the species, I have inserted them, but between brackets. Mr. Petterd is, however, such an experienced observer, and the species have been so well identified by him, as a rule, that full confidence may be placed in his determinations of the species noticed.

The following brief account of the expedition is extracted from an article of mine in 'Nature' for August 17th, 1876:—"Mr. Stone started from Somerset, Australia, on October 21st, 1875, and after remaining a few days at Yule Island, where Signor D'Albertis was then collecting, he reached Port Moresby, New Guinea, about sixty miles further to the south-east, on the 29th of the same month. Although his principal object in visiting the island was to gain ethnological and geographical information, he took with him two taxidermists. Anuapata, where he erected his tent, is situated upon the shores of Moresby Harbour, in long. 147° 7′ E., and lat. 9° 28′ S.; and from here several preliminary excursions were made. At first the natives showed some fear; but on seeing that the object of the visitors was peaceable, they soon gained confidence, and the younger members of the community frequently assisted in carrying back the game shot. During the months of December and January rain fell in considerable quantities, and both the collectors were laid up for many days with fever and ague, which retarded collecting; but altogether about 450 skins of birds were obtained from a radius of about thirty miles inland from Port Moresby. In the immediate neighbourhood of Port Moresby birds were plentiful; but the beautiful Bird of Paradise (*P. raggiana*) is only found in the thick forests on the mountains of the interior. Parrakeets, Parrots, and Cockatoos, Pigeons, and Doves were numerous among the jungle and the belts of tall trees along the rivers Laroki * and Vetura. The furthest point reached inland was Munikaihila, situated about thirty miles to the north-east, the difficulty in procuring natives

* Mr. Ramsay, *l. c.* p. 387, spells this "Laloki," but "Laroki" was insisted on by Mr. Stone as the correct orthography.

as carriers preventing Mr. Stône from proceeding further. At this point he made a camp for several days; but the wet season and consequent unhealthiness of the place precluded further exploration."

The papers written by Count Salvadori on the Ornithology of South-eastern New Guinea have again been referred to in the preparation of the present article; and just as I was going to press, I saw the fourth Part of vol. i. of the 'Proceedings of the Linnean Society of New South Wales,' in which occurs the following paper of Mr. Ramsay's:—

"Notes on a Collection of Birds from Port Moresby; with Descriptions of some new Species. By E. P. Ramsay, F.L.S." Proc. Linn. Soc. N. S. W. i. pp. 386–395.

Some of the species described had here received new names from me, which I am happy to suppress in time, and so avoid an increase of synonyms.

Order ACCIPITRES.

Fam. Falconidæ.

1. Accipiter cirrhocephalus?—A. cirrhocephalus (*V.*), *Sharpe, Cat. B.* i. p. 141.

Loc. Port Moresby.

A young Sparrow-Hawk which Mr. Petterd believes to be the same as the common Australian species, with which he is well acquainted. It appears to me, from a comparison of skins, that it is of this species, although an examination of adult birds would be required to decide the question.

2. Astur cruentus, *Gould, P. Z. S.* 1842, p. 113 (*nec Sharpe, Cat.* i. p. 127); *Salvad. Ann. Mus. Civic. Genov.* vii. p. 806.—Urospizus cruentus, *id. op. cit.* ix. p. 11.

Loc. a, ad. "Plentiful on the coast."

General colour above ashy brown (worn plumage), the new feathers appearing being of a dark grey colour; head deep slaty grey, rather clearer on the nape; hind neck tawny rufous, forming a distinct collar; wing-coverts and quills slaty grey, the latter rufous buff on the inner webs, with indistinct bars of dusky brown; tail-feathers ashy brown, covered with about sixteen dusky bars, more distinct on the inner webs, which are lighter; sides of head ashy grey, slightly clearer than the crown; throat

grey, mottled with irregular whitish cross bars; rest of under surface of body light tawny red, transversely barred with greyish white, these white bars much broader on the abdomen and under tail-coverts, which are white barred with rufous; the sides of the breast nearly uniform rufous: under wing-coverts and axillaries pale tawny like the breast, and narrowly barred with white, the outer coverts and the edge of the wing white with a few rufous bars; quills brown below, pale creamy rufous towards the base of the feathers, and narrowly barred with dusky brown on the inner webs. Total length 16 inches, culmen 1·1, wing 10·4, tail 7·7, tarsus 2·7.

This Goshawk is not *A. approximans*, as it is so much clearer grey, so much lighter below, and, moreover, has a broad red collar round the hind neck. The latter feature separates it from *A. wallacii*, which, moreover, has the throat and thighs reddish. Its nearest ally proves, therefore, to be *A. torquatus* of Timor, with which Count Salvadori now identifies it; but in addition to the larger proportion of rufous on the under parts, the New-Guinea bird has the under tail-coverts barred with rufous, whereas in *A. torquatus* they are entirely white, the thighs also being nearly all white. These may, however, be merely individual differences.

Count Salvadori has recorded a Goshawk from Yule Island, which he is inclined to refer to *A. cruentus* (Gould). I think he makes out a good case against my *A. cruentus* of the 'Catalogue of Birds' (p. 127); for I fancy the bird described by me must be only *A. approximans*: this I have thought for some time, as I have watched a specimen living in the Zoological Gardens which got whiter below as it grew older till it much resembled the specimen described. At the same time the Yule-Island Goshawk, *if* it is the same as the bird now brought by Mr. Stone, can hardly be the true *A. cruentus* of Gould, according to the figure of the hind neck; but the description agrees in stating that there is a chestnut collar round the latter. It is a great drawback that Mr. Gould gives no measurements; but sooner than create a new species on certain slender differences, I shall follow Count Salvadori in considering this to be the true *A. cruentus* until such time as an examination of the typical bird from West Australia proves us right or wrong. The measurements of the present bird approach very closely to those given by Count Salvadori.

Dr. James procured a young Goshawk in South-east New

Guinea, which I could not identify from an immature specimen; but it is certainly the young of *A. cruentus* as determined above. It bears the following label:—"Mainland, east of Yule Island. Eucalyptus range of hills, Sept. 1875." Mr. Ramsay (*t. c.* p. 387) mentions a Goshawk allied to *A. muelleri* or *A. etorques*.

3. HALIAËTUS LEUCOGASTER (*Gm.*); *Sharpe*, anteà, p. 308; *Ramsay*, *t. c.* p. 387.

Loc. "Obtained on the coast."

4. HALIASTUR GIRRENERA (*V.*); *Sharpe*, anteà, p. 308.

Loc. One specimen shot near Port Moresby.

5. MILVUS AFFINIS, *Gould*; *Sharpe, Cat. B.* i. p. 323; *Salvad. & D'Albert. Ann. Mus. Civic. Genov.* vii. p. 805; *Ramsay, t. c.* p. 387.

A young specimen, with no exact locality indicated.

6. BAZA REINWARDTI, *Müll. & Schl.*; *Sharpe*, anteà, p. 309.—B. stenozoa, *Ramsay, t. c.* p. 387.

Loc. "Inland and on the coast."

Mr. Ramsay notices how closely *B. reinwardti* resembles *B. subcristata* of Australia, of which it is little more than a small race.

7. PANDION LEUCOCEPHALUS (*Gould*); *Sharpe*, anteà, p. 309.

Loc. Port Moresby.

Fam. STRIGIDÆ.

8. STRIX FLAMMEA, *L.*; *Sharpe, Cat. B.* ii. p. 291.—Strix delicatulus, *Ramsay, t. c.* p. 388.

Loc. Port Moresby.

Two specimens, of the usual pale Australian type (*Strix delicatulus* of Gould).

Order PICARIÆ.

Fam. PSITTACIDÆ.

9. PLYCTOLOPHUS TRITON (*Temm.*); *Finsch, Papag.* i. p. 291.—Cacatua triton, *Salvad. Ann. Mus. Civic. Genov.* ix. p. 11, x. p. 24.

Agrees with a specimen from Dorey (*Wallace*) in the British Museum. The species is identified in Mr. Petterd's list, where it is stated to be generally distributed. A second species is mentioned as being seen some distance inland.

[10. MICROGLOSSUM ATERRIMUM. — M. aterrimum (*Gm.*); *Salvad. Ann. Mus. Civic. Genov.* x. p. 24; *Ramsay, t. c.* p. 394.

Loc. Port Moresby.]

11. GEOFFROYIUS ARUENSIS (*Gray*); *Sharpe*, anteà, p. 309; *Salvad. op. cit.* x. p. 29.

Loc. Laroki River.

An adult male, agreeing with Aru examples.

12. CYCLOPSITTA SUAVISSIMA, *Sclater*, *P. Z. S.* 1876, p. 520, pl. liv.; *Gould, B. New Guinea*, part iv.—Cyclopsittacus suavissima, *Salvad. t. c.* p. 12; *id. op. cit.* x. p. 29; *Ramsay, t. c.* p. 393.

Loc. Laroki River.

The single specimen obtained seems to be a young male, as it is intermediate between the two specimens figured by Dr. Sclater (*l. c.*). It resembles the female bird in the plate, but has the orange neck-patch mixed with blue on its lower part, and the breast, though dull as in the female, has a few bright orange feathers intermixed.

13. TRICHOGLOSSUS MASSENA, *Bp.*; *Sharpe*, anteà, pp. 80 & 309; *Salvad. t. c.* p. 35; *Ramsay, t. c.* p. 393.

Loc. Several specimens from Port Moresby.

14. CHALCOPSITTACUS CHLOROPTERUS, *Salvad. Ann. Mus. Civic. Genov.* ix. p. 15; *id. op. cit.* x. p. 34.—Chalcopsitta rubrifrons, *Ramsay, t. c.* p. 393.

Loc. Port Moresby.

A very doubtful species. All the three specimens examined by me have a varying amount of red on the under wing-coverts, while two of them have quite as much yellow on the inner face of the quills as in Dorey and Aru examples.

15. ECLECTUS POLYCHLORUS (*Scop.*); *Salvad. op. cit.* x. p. 31; *Ramsay, t. c.* p. 393.

Loc. "Generally distributed."

Fam. CUCULIDÆ.

16. CENTROPUS SPILOPTERUS, *Gray*; *Sharpe*, anteà, pp. 81 & 310.—Centropus melanurus, *Ramsay, t. c.* p. 394.

Loc. Several specimens from Port Moresby.

17. C. MENEBEKI (*Less.*); *Sharpe*, anteà, pp. 81 & 311.

Loc. Port Moresby.

18. EUDYNAMIS CYANOCEPHALA (*Lath.*); *Salvad. op. cit.* ix. p. 17.

Loc. Barune.

19. Cacomantis assimilis, *Gray*; *id. Hand-l. B.* ii. p. 217.

Loc. Port Moresby.

This specimen agrees with a specimen of *C. assimilis* from Mysol in nearly every particular.

[20. Scythrops novæ-hollandiæ, *Lath.*; *Salvad. & D'Albert. t. c.* p. 813; *Ramsay, t. c.* p. 394.

Loc. Generally distributed.]

Fam. Alcedinidæ.

21. Ceyx solitaria, *Temm.*; *Sharpe, Monogr. Alced.* pl. 38.

Loc. "Island brushes near Port Moresby."

An adult specimen. The dimensions are as follows:—Total length 4·7 inches, culmen 1·4, wing 2·15, tail 1·05, tarsus 0·3. D'Albertis has not met with this species in South-eastern New Guinea.

22. Alcyone lessoni, *Cass.*; *Sharpe*, anteà, p. 311.

Loc. Laroki River.

Count Salvadori refers D'Albertis's specimens from S.E. New Guinea to this species; and on comparison I find Mr. Stone's bird agrees better with it than with *A. pulchra*. Total length 6·5 inches, culmen 1·75, wing 3·05, tail 1·7, tarsus 0·45. As is the case with the bird mentioned by Count Salvadori, the blue spot is confined to the sides of the breast, and does not extend on to the flanks.

23. A. pusilla, *Gould*; *Sharpe*, anteà, p. 311.

Loc. Laroki River.

An adult bird, agreeing with specimens from Gilolo (*Wallace*) and Aru Islands (*Wallace*). Total length 4·2 inches, culmen 1·2, wing 2·1, tail 0·95, tarsus 0·3.

[24. Halcyon sanctus, *V. & H.*; *Ramsay, t. c.* p. 390.—Sauropatis sancta, *Salvad. & D'Albert. t. c.* p. 814.

Loc. Port Moresby.]

[25. H. macleayi, *J. & S.*; *Ramsay, t. c.* p. 390.—Cyanalcyon macleayi, *Salvad. & D'Albert. t. c.* p. 815.

Loc. Momile.]

26. Syma torotoro, *Less.*; *Salvad. op. cit.* ix. p. 20; *Ramsay, t. c.* p. 390.

Loc. "Inland brushes."

Agrees best with an Aru-Island skin. The bill is perfectly yellow, of the same deep tinge as is usual in Papuan skins. Total length 7·5 inches, culmen 1·45, wing 3·05, tail 2·85, tarsus 0·5.

27. TANYSIPTERA MICRORHYNCHA, *Sharpe*, anteà, p. 311.—T. galatea, *Ramsay*, *t. c.* p. 390.

Loc. "Inland brushes."

[28. T. SYLVIA, *Gould*; *Sharpe*, *Monogr. Alced.* pl. 100.

Loc. "Oko Creek." No specimens were in the collection.]

29. DACELO INTERMEDIUS, *Salvad.*; *Sharpe*, anteà, p. 312.—D. leachii, *Ramsay*, *t. c.* p. 389.

Loc. Port Moresby; very plentiful.

30. D. GAUDICHAUDI (*Less.*); *Sharpe*, anteà, p. 313; *Ramsay*, *t. c.* p. 389.

Loc. Laroki River.

Fam. BUCEROTIDÆ.

31. RHYTIDOCEROS RUFICOLLIS (*V.*); *Sharpe*, anteà, p. 314.—B. flavicollis, *Ramsay*, *t. c.* p. 393.

Loc. Generally distributed.

Fam. CORACIIDÆ.

32. EURYSTOMUS CRASSIROSTRIS, *Sclater*; *Salvad. & D'Albert. Ann. Mus. Civic. Genov.* vii. p. 814; *Salvad. op. cit.* ix. p. 19; *Ramsay*, *t. c.* p. 389.

Loc. Momile.

I follow Count Salvadori in referring the Roller of S.E. New Guinea to *E. crassirostris*. It is similar in colour, but has not quite so stout a bill as the Solomon-Island species, which also has no black tip to the culmen. Mr. Ramsay also includes *E. pacificus* in his list.

Fam. CAPRIMULGIDÆ.

33. PODARGUS PAPUENSIS, *Q. & G.*; *Salvad. & D'Albert. t. c.* p. 816; *Salvad. op. cit.* x. p. 22; *Ramsay*, *t. c.* p. 388.

Loc. "Abundant at Port Moresby."

Mr. Stone has brought back a large series of this Goatsucker, showing every shade between the dark and the light forms.

34. CAPRIMULGUS MACRURUS, *Horsf.*; *Salvad. & D'Albert. t. c.* p. 817; *Salvad. op. cit.* ix. p. 23.

Loc. Port Moresby.

Identical with Australian examples in coloration. Total length 10·5 inches, wing 7·15, tail 5·7, tarsus 0·55.

Fam. Cypselidæ.

35. Cypselus pacificus (*Lath.*), *Sclater, P. Z. S.* 1865, p. 599.

Loc. Port Moresby. One adult specimen obtained.

[36. Collocalia terræ-reginæ, *Ramsay, P. Z. S.* 1874, p. 601; *Gould, Birds of New Guinea*, part i.

Observed, according to Mr. Petterd; but no specimens were sent.]

Order PASSERES.

Fam. Pittidæ.

37. Pitta novæ-guineæ, *Müll. & Schl.*; *Sharpe*, anteà, p. 315.

Loc. "Generally distributed in the brushes."

Fam. Turdidæ.

38. Malurus alboscapulatus, *Meyer*; *Sharpe*, anteà, p. 315.

Loc. Plentiful at Port Moresby.

Dr. Meyer's type specimen having been sent by him to Mr. Gould, I have had an opportunity of comparing Mr. Stone's specimens with it. I find them identical in plumage; but the bird from S.E. New Guinea is smaller. Total length 4·1 inches, culmen 0·5, wing 1·8, tail 1·65, tarsus 0·85. Probably twenty specimens were in Mr. Stone's collection, but unfortunately the sexes were not indicated. I could, however, perceive no difference in colour beyond a less glossy appearance in some. These were probably females, as D'Albertis's specimens seem to resemble the males exactly.

39. Cisticola ruficeps, *Gould*; *Sharpe*, anteà, p. 315.

Loc. Port Moresby.

All Mr. Stone's examples are similar and agree with Cape-York specimens of *C. ruficeps.*

40. Gerygone cinerascens, sp. n.

General colour above ashy brown, with a faint tinge of olive on the rump; wing-coverts brown, narrowly edged with whity brown; quills brown, edged externally with whity brown, these edges broader and paler on the secondaries; two centre tail-feathers ashy brown, subterminally darker brown; rest of the tail-feathers ashy brown, with a large white spot on the tip of the inner web, before which is a broad subterminal bar of black, the inner web below this having another white notch; at the base of the bill a line of white feathers; region of the eye and ear-coverts light brown; cheeks and entire

throat pure white; rest of under surface of body bright yellow, paling on the thighs and under tail-coverts; under wing-coverts white, the quills greyish brown, with white edgings along the inner webs. Total length 3·4 inches, culmen 0·45, wing 2·15, tail 1·45, tarsus 0·7.

This species is allied to *G. palpebrosa*, but is ashy above instead of green, and has not a black ring round the eye; the quills are margined with whitish instead of olive, and the white markings on the tail are a very peculiar characteristic. A specimen from N.W. Australia (*Elsey*) appears to belong to the same species.

41. Gerygone chrysogastra, *Gray*; *Salvad. & D'Albert. t. c.* p. 820; *Salvad. t. c.* p. 26.

Agrees with a specimen from the Aru Islands. Total length 4·2 inches, culmen 0·5, wing 2·1, tail 1·75, tarsus 0·65.

42. Ælurœdus stonii, *Sharpe, Nature*, Aug. 17, 1876, p. 339; *Salvad. Ann. Mus. Civic. Genov.* ix. p. 193.

Adult. General colour above bright green, some of the feathers tinged with blue; wings green like the back, the inner webs dusky brown, the primaries externally washed with yellow, the secondaries tipped with the latter colour; tail green, blackish on the inner webs of the outermost rectrices, which are tipped with white; head dark brown, slightly washed with olive; hind neck yellowish buff, mottled with black centres to the feathers, those adjoining the mantle spotted with green; sides of face and throat pure white, with a few tiny spots of black on the ear-coverts, larger on the sides of the neck; rest of under surface of body ochraceous buff, the fore neck and chest minutely spotted with green, the flanks also with a few tiny spots of the latter colour; under wing-coverts yellowish buff, the edge of the wing washed with green. Total length 9·3 inches, culmen 1·15, wing 5·05, tail 3·5, tarsus 1·55.

This new species is the southern representative of *Æ. buccoides* of the north-west of New Guinea, from which it differs in its much darker head and in the nearly uniform under surface, the abdomen and under tail-coverts being quite unspotted, and the breast having only a few scattered green spots, whereas in *Æ. buccoides* the whole under surface is thickly spotted with large drops of black.

43. Chlamydodera cerviniventris.—C. cerviniventris, *Gould*; *Sharpe*, anteà, p. 82; *Salvad. op. cit.* ix. p. 193; *Ramsay, t. c.* p. 393.

Loc. Port Moresby.

Quite a number of specimens were brought back by Mr. Stone, showing the abundance of the species near Port Moresby.

Fam. Dicæidæ.

44. Dicæum rubrocoronatum, *Sharpe, Nature,* August 17, 1876, p. 339; *Salvad. Ann. Mus. Civic. Genov.* ix. p. 31; *Ramsay, t. c.* p. 390.

Loc. Port Moresby.

Adult. Above deep purple, the crown and the upper tail-coverts scarlet, forming a coronal patch on the former; sides of head and neck dusky, with a slight olivaceous gloss; wing-coverts purple like the back, the quills black, glossed with purple, the primaries slightly edged with olivaceous; tail purplish black; under surface of body yellowish buff, the under tail-coverts slightly tinged with red; the sides of the body ashy grey, washed with olive on the lower flanks; across the fore neck a band of scarlet; under wing-coverts pure white, the edge of the wing purplish black; quills blackish below, edged with white along the inner web. Total length 3·15 inches, culmen 0·4, wing 2·05, tail 1·1, tarsus 0·5.

The female differs from the male in being duller in colour and in wanting the scarlet throat-patch; the upper surface is more shaded with olive, and there is a more decided olivaceous tinge on the flanks.

Fam. Cinnyridæ.

45. Cinnyris frenatus (*S. Müll.*); *Sharpe,* anteà, p. 316; *Ramsay, t. c.* p. 390.

Loc. Port Moresby.

Fam. Meliphagidæ.

46. Glyciphila modesta, *Gray*; *Sharpe,* anteà, p. 316.—G. subfasciata, *Ramsay, P. Z. S.* 1868, p. 385.

Loc. Port Moresby.

Mr. Petterd in his list enters both *G. modesta* and *G. subfasciata,* Ramsay; but these two species appear to be identical on comparing Australian examples of the latter in Mr. Gould's collection with the New-Guinea bird.

47. Myzomela obscura, *Gould*; *Salvad. t. c.* p. 32.

Loc. Port Moresby.

I have compared the single specimen sent with another in the Museum from N.W. Australia, and can find no difference.

48. Tropidorhynchus novæ guineæ, *S. Müll.*; *Salvad. & D'Albert. t. c.* p. 826; *Salvad. t. c.* p. 34.—Philemon novæ guineæ, *Ramsay, t. c.* p. 390.

Loc. Port Moresby. Abundant.

49. Ptilotis analoga, *Reichenb.*; *Salvad. t. c.* p. 32.

The single specimen collected seems to be rather small. Total length 5·3 inches, culmen 0·75, wing 2·75, tail 2·4, tarsus 0·8.

50. Melithreptus albigularis, *Gould*; *Ramsay, t. c.* p. 391.

Loc. Port Moresby.

Two specimens identical with one from the Australian continent.

Fam. Muscicapidæ.

51. Arses telescophthalmus (*Garn.*); *Sharpe*, anteà, p. 316; *Ramsay, t. c.* p. 391.

Loc. Laroki River.

Mr. Petterd also gives *A. kaupi* as a distinct species, from the same river.

♂. Total length 6 inches, culmen 0·65, wing 3·15, tail 2·95, tarsus 0·75. ♀. Total length 5·9 inches, culmen 0·6, wing 3, tail 2·7, tarsus 0·75.

52. Monarcha aruensis, *Salvad. Ann. Mus. Civic. Genov.* vol. vi. p. 309.—M. melanonotus, *Sclater, P. Z. S.* 1877, p. 100.

Loc. Momile. "Only one specimen shot."

Dr. Sclater has shown clearly that the true *M. chrysomelas* from New Ireland is a distinct bird from the New-Guinea species, which he calls *M. melanonotus*; but I cannot find any difference between New Guinea and Aru examples, in which case the name to be employed is *M. aruensis*.

53. M. guttulatus (*Garn.*); *Salvad. & D'Albert. t. c.* p. 818.

Loc. Momile. One specimen.

54. M. carinata.—M. carinatus (*V. & H.*); *Salvad. & D'Albert. t. c.* p. 818; *Salvad. t. c.* p. 24; *Ramsay, t. c.* p. 391.

Loc. Port Moresby.

Two specimens of a grey and tawny *Monarcha*, doubtless of the same species which Count Salvadori calls *M. carinata*. They have not such a broad frontal band as the latter, and in fact have only a dusky indication of blackish on the forehead and chin. *M. inornata*, however, has none at all; and although the New-

Guinea bird seems to be intermediate, I propose to keep it under *M. carinata.*

55. Monarcha tricolor.—Sauloprocta tricolor (*V.*); *Salvad. & D'Albert. t. c.* p. 819; *Salvad. op. cit.* ix. p. 24; *Ramsay, t. c.* p. 392.

Loc. Laroki River.

56. Rhipidura gularis, *Müll.*; *Salvad. & D'Albert. t. c.* p. 820; *Salvad. op. cit.* ix. p. 24.—R. isura, *Gould*; *Ramsay, t. c.* p. 391.

Loc. Laroki River.

57. Micrœca flavigaster.—M. flavigaster, *Gould*; *Salvad. & D'Albert. t. c.* p. 817; *Salvad. op. cit.* ix. p. 23.

Loc. Port Moresby.

When compared with *M. flavigaster* of N.E. Australia, the Port-Moresby skin seems to be a little larger, and to have a narrow yellow eyebrow. Total length 4·6 inches, culmen 0·45, wing 3·1, tail 2·1, tarsus 0·55.

58. Todopsis bonapartii, *Gray*; *Sharpe*, anteà, p. 316.

Loc. Momile. A pair of birds sent.

The male is scarcely distinguishable in any way from *T. bonapartii* of the Aru Islands, and has the mantle dark purple, but so nearly the colour of the mantle in *T. bonapartii* that there can be no reason for separating the birds specifically, as far as I can see at present. Certainly the species is not *T. cyanocephala.* The female agrees apparently with that of the Aru-Island bird, but has the blue throat perhaps not quite so far extended.

59. Myiagra concinna, *Gould*; *Salvad. & D'Albert. t. c.* p. 819; *Salvad. op. cit.* ix. p. 24.

Loc. Laroki River.

60. M. latirostris, *Gould, B. Austr.* ii. pl. 92.

Loc. Laroki River.

61. Piezorhynchus nitidus, *Gould*; *Sharpe*, anteà, p. 316; *Ramsay, t. c.* p. 391.

Loc. Port Moresby.

Fam. Hirundinidæ.

62. Hirundo javanica, *Sparrm.*; *Salvad. t. c.* p. 23.—H. fretensis, *Ramsay, t. c.* p. 388.

Loc. Port Moresby.

Rather lighter on the under surface than typical Javan and Sumatran specimens, but evidently of the same species. It agrees best with a Dorey skin obtained by Wallace.

Fam. Laniidæ.

63. Cracticus mentalis, *Salvad. & D'Albert.*; *Sharpe*, anteà, p. 317.—Vanga mentalis, *Ramsay, t. c.* p. 392.

Loc. Port Moresby.

64. C. cassicus (*Bodd.*); *Sharpe*, anteà, p. 317.

Loc. Port Moresby.

65. C. quoyi, *Less.*; *Gould, Handb. B. Austr.* i. p. 183.—Vanga quoyi, *Ramsay, t. c.* p. 392.

Loc. Port Moresby.

a. Total length 13 inches, culmen 1·95, wing 6·75, tail 5·65, tarsus 1·5.

Fam. Campephagidæ.

66. Graucalus angustifrons, *Sharpe*, anteà, p. 81.

Loc. Port Moresby.

Agrees with the type specimen before described.

67. Lalage karu (*Less. & Garn.*); *Salvad. op. cit.* ix. p. 28.

Loc. Port Moresby.

A young bird, answering to the description given by Count Salvadori.

68. L. humeralis, *Gould*; *Gray, Hand-l. B.* i. p. 339. no. 5116.

An adult specimen agreeing with others from Australia.

Fam. Prionopidæ.

69. Rectes ferruginea, *Bp.*; *Sharpe*, anteà, p. 317.

Loc. Munikaihila.

70. Colluricincla brunnea, *Gould*; *Salvad. t. c.* p. 29; *Ramsay, t. c.* p. 391; *Sharpe, Cat. B.* iii. p. 291.

Loc. Port Moresby.

Agrees with a specimen from Cape York in the British Museum. The species from the westward (Port Essington and Nicholson River) seems to be distinct; and I have called it *C. pallidirostris* (Cat. B. iii. p. 293). The Port-Moresby skin measures as follows:—Total length 8·5 inches, culmen 1·05, wing 4·65, tail 4·7, tarsus 1·3.

Fam. Dicruridæ.

71. Chibia carbonaria (*Müll.*); *Sharpe, Cat. B.* iii. p. 239.

—Dicrurus carbonarius, *Salvad. & D'Albert. t. c.* p. 821; *Salvad. t. c.* p. 28; *Ramsay, t. c.* p. 392.

Loc. Port Moresby.

The specimen agrees with other Papuan skins, and measures as follows:—Total length 11·5 inches, culmen 1·3, wing 6·0, tail 4·8, tail-feather 5·55, tarsus 0·9. Mr. Petterd also records a second species from the Laroki River, which, he says, was allied to *C. assimilis*. Only one species was in the collection.

Fam. ORIOLIDÆ.

72. ORIOLUS STRIATUS, *Q. & G.*; *Sharpe*, anteà, pp. 82 & 318, et *Cat. B.* iii. p. 210; *Ramsay, t. c.* p. 391.

Loc. Port Moresby.

Several specimens of this bird, which appears to be common in the neighbourhood.

73. SPHECOTHERES SALVADORII, *Sharpe, Cat. B.* iii. p. 224, pl. xii.

This new species, fully described and figured by me in the 'Catalogue of Birds,' is much smaller than *S. maxillaris*, and is distinguished by its yellower under parts and by its whiter abdomen. Mr. Ramsay does not seem to have seen this bird, though he has *S. flaviventris* from Port Moresby. Signor D'Albertis also has not yet recorded it, which is curious, as Mr. Stone brought back four examples, and Canon Tristram has also received it from S.E. New Guinea.

Fam. PARADISIIDÆ.

74. PARADISEA RAGGIANA, *Sclater*; *Sharpe*, anteà, p. 318; *Ramsay, t. c.* p. 393.

Loc. Munikaihila.

A series of specimens in all stages of plumage.

75. MANUCODIA ATRA (*Less.*); *Sharpe*, anteà, p. 317.

Loc. Port Moresby.

76. PHONYGAMA JAMESII, *Sharpe*, anteà, p. 318; *Cat. B.* iii. p. 181.

Loc. Laroki River.

Notwithstanding Count Salvadori's opinion that *P. keraudreni* is the species of South-eastern New Guinea, I believe that *P. jamesii* is a good and distinct species.

77. Ptilorhis magnifica (*V.*); *Sharpe, Cat. B.* iii. p. 157.

Loc. Munikaihila.

A female in rufous plumage, which shows that the species is true *P. magnifica* and not *P. alberti* of N.E. Australia.

Fam. Corvidæ.

78. Gymnocorax senex, *Less.*; *Sharpe, Cat. B.* iii. p. 50.—Gymnocorus senex, *Ramsay, t. c.* p. 392.

Loc. Munikaihila.

An apparently adult specimen in worn plumage. Total length 20 inches, culmen 2·65, wing 12·9, tail 9·7, tarsus 2·35.

[79. Corvus orru, *Müll.*—Corone orru, *Sharpe*, anteà, p. 318. —Corvus orru, *Ramsay, t. c.* p. 392.

Loc. Port Moresby.]

Fam. Sturnidæ.

80. Eulabes dumonti (*Less.*); *Sharpe*, anteà, p. 318.—Gracula dumontii, *Ramsay, t. c.* p. 392.

Loc. Port Moresby.

81. Calornis cantoroides, *Gray*; *Salvad. t. c.* p. 38.—C. cantor, *Ramsay, t. c.* p. 393.

Loc. Port Moresby.

Count Salvadori disputes my conclusion that *C. cantoroides* is only the young of *C. mysolensis*; and after re-examining the question by the light of Mr. Stone's specimens, I believe him to be right, and that my determination was a mistake.

82. C. viridescens, *Gray*; *Sharpe*, anteà, p. 318.

Loc. "In the brushes near Port Moresby."

Fam. Artamidæ.

[83. Artamus leucopygialis, *Gould*; *Ramsay, t. c.* p. 392.

Loc. Port Moresby.]

84. Donacola nigriceps, *Ramsay, t. c.* p. 392.

Loc. Laroki River.

Adult. General colour above delicate burnt sienna, with ashy shading to the feathers of the back; the rump and upper tail-coverts orange, with dusky bases to the feathers; tail-feathers pointed, dark brown, with straw-yellow margins, the two centre feathers almost entirely straw-yellow; head and nape chocolate-

brown, veined with streaks and spots of ashy whitish, the nape-feathers edged with the latter colour; lores, feathers above the eye, entire sides of face, and throat uniform black; fore neck and chest entirely pinkish fawn-colour, forming a large plastron, succeeded by a band of black across the lower breast; centre of the body and abdomen pure white, the flanks regularly barred with black and white; thighs and under tail-coverts black; under wing-coverts buffy white, the edge of the wing minutely barred with black and white; wing-coverts above sienna-brown; quills light brown, externally washed with sienna-brown, ashy brown below, edged with buff along the inner web. Total length 3·8 inches, culmen 0·4, wing 2, tail 1·55, tarsus 0·6.

This species is a representative of the Australian *Donacola castaneothorax*, to which it is closely allied, but from which it is distinguished by its entirely black face, without any brown streaks on the ear-coverts, and by its dark head, which, instead of being entirely ashy, is blackish, only spotted with ash-colour. I had already discriminated this species and described it in full when I got Mr. Ramsay's paper with a name for it, and am glad that he also considers it distinct.

Order COLUMBÆ.

Fam. Columbidæ.

85. Chalcophaps stephani, *Pucher. & Jacq.*; *Salvad. Ann. Mus. Civic. Genov.* ix. p. 206; *Salvad. t. c.* x. p. 44.

Loc. Momile.

86. C. chrysochlora (*Wagl.*); *Sharpe*, anteà, p. 319; *Salvad. t. c.* p. 206.

Loc. Oko Creek, &c.

Fam. Carpophagidæ.

87. Carpophaga muelleri, *Temm.*; *Sharpe*, anteà, p. 319; *Salvad. t. c.* p. 202; *Ramsay, t. c.* p. 394.

Loc. Laroki River.

88. C. pinon (*Q. & G.*); *Sharpe*, anteà, p. 319; *Salvad. t. c.* p. 202; *Ramsay, t. c.* p. 394.

Loc. Laroki River.

89. C. zoeæ (*Less.*); *Salvad. t. c.* p. 201.

Loc. Laroki River.

90. Carpophaga puella (*Less.*); *Ramsay, t. c.* 394.—Megaloprepia puella, *Salvad. t. c.* p. 199.

Loc. Laroki River.

91. Ianthœnas albigularis, *Bp.*; *Salvad. t. c.* p. 203.—Ianthœnas rawlinsoni, *Sharpe, Nature*, Aug. 17, 1876.

Adult. General colour above metallic green with coppery-violet reflexions, the appearance of the back being grey when seen away from the light; head, mantle, and under surface of body coppery violet, the bases of the feathers leaden grey on the under parts; cheeks, ear-coverts, and throat creamy white; under tail-coverts leaden black, with narrower margins of coppery violet; under wing-coverts and axillaries leaden grey; wings above black, washed with leaden grey, the coverts narrowly edged with the same colour as the back, the margins also very narrow on the inner secondaries, scapulars, and long upper tail-coverts; tail black. Total length 14·5 inches, culmen 0·8, wing 9·85, tail 5·9, tarsus 1·2.

On comparing more closely the Pigeon described by me as *I. rawlinsoni*, I have come to the conclusion that it must not be separated from *I. albigularis*, Bp.; there are some slight differences between it and the Mysore skin in the Museum, but not sufficient to warrant me in sustaining the species.

92. Ptilonopus iozonus, *Gray*; *Salvad. & D'Albert. l. c.* p. 834; *Salvad. t. c.* p. 42; *id. op. cit.* ix. p. 198; *Ramsay, t. c.* p. 394.

Loc. Laroki River.

Agrees with specimens from the Aru Islands.

93. P. aurantiifrons, *Gray*; *Salvad. t. c.* p. 197.

Loc. Laroki River.

94. P. coronulatus, *Gray*; *Sharpe*, anteà, p. 320; *Salvad. t. c.* p. 198; *Ramsay, t. c.* p. 394.

Loc. Laroki River.

a. Total length 8·1 inches, culmen 0·55, wing 4·65, tail 3·05, tarsus 0·8.

95. Geopelia humeralis (*Temm.*); *Salvad. & D'Albert. t. c.* p. 836; *Salvad. t. c.* p. 205.

Loc. Laroki River.

96. Goura albertisi, *Salvad.*; *Sharpe*, anteà, p. 318; *Ramsay, t. c.* p. 394.

Order GALLINÆ.

Fam. MEGAPODIDÆ.

97. MEGAPODIUS DUPERREYI, *Less.*; *Salvad. & D'Albert. t. c.* p. 838; *Salvad. t. c.* p. 48; *Ramsay, t. c.* p. 394.

Loc. "Generally distributed."

Identical in coloration with Aru examples, but having rather a larger foot; middle toe and claw 2·6 inches.

98. TALEGALLUS FUSCIROSTRIS, *Salvad. Ann. Mus. Civic. Genov.* ix. p. 334.—Megapodius cuvieri, *Ramsay, t. c.* p. 394.

Loc. "Brushes in the interior."

Mr. Ramsay observes:—"This is undoubtedly a *Megapodius*, and not a *Talegalla*. The egg resembles that of *M. tumulus*, but is much larger, being 3·9 inches in length, 2·48 in breadth, and of a rich salmon-ochre colour."

Fam. PERDICIDÆ.

99. SYNŒCUS CERVINUS, *Gould.*—Synoicus cervinus, *Ramsay, t. c.* p. 394.

Loc. Widely distributed.

Order GRALLÆ.

Fam. CHARADRIIDÆ.

100. LOBIVANELLUS MILES.—Chettusia miles (*Bodd.*); *Gray, Hand-l. B.* iii. p. 12.

Loc. Port Moresby.

101. CHARADRIUS FULVUS, *Gm.*; *Sharpe & Dresser, B. Eur.* part ix.

Loc. Port Moresby. Two specimens in winter plumage.

[102. NUMENIUS UROPYGIALIS, *Gould*; *Salvad. t. c.* ix. p. 48; *Ramsay, t. c.* p. 394.

Loc. Port Moresby.]

103. TOTANUS BREVIPES, *Cuv.*; *Gray, Hand-l. B.* iii. p. 45.

Loc. Port Moresby.

[104. ACTITIS HYPOLEUCUS (*L.*).—A. empusa, *Ramsay, t. c.* p. 394.

Loc. Port Moresby.]

Fam. ARDEIDÆ.

105. ARDEA SACRA, *Gm.*; *Gray, Hand-l. B.* iii. p. 28.

Loc. Port Moresby.

106. A. FLAVICOLLIS, *Lath.*; *Gray, Hand-l. B.* iii. p. 30.

One specimen.

Fam. RALLIDÆ.

107. RALLINA PLUMBEIVENTRIS, *Wall.*; *Gray, Hand-l. B.* iii. 58.

Loc. Momile.

I have compared Mr. Stone's specimen with the type from Morty Island, and find the two birds identical.

108. GALLINULA RUFICRISSA, *Gould*; *Gray, Hand-l. B.* iii. p. 67; *Ramsay, t. c.* p. 395.

Loc. Port Moresby.

109. PORPHYRIO MELANOPTERUS (*Temm.*); *Sharpe*, anteà, p. 320; *Ramsay, t. c.* p. 393.

Loc. Port Moresby.

This specimen bears out what Count Salvadori writes respecting this bird. It has the fore part of the breast, the lesser wing-coverts, and the edge of the wing brighter blue than in *P. melanonotus*. I therefore follow Count Salvadori in referring it to *P. melanopterus*.

[110. PARRA CRISTATA, *V.*; *Gray, Hand-l. B.* iii. p. 70.

Loc. Laroki River.]

Order ANSERES.

Fam. ANATIDÆ.

[111. ANAS SUPERCILIOSA, *Gm.*; *Gray, Hand-l. B.* iii. p. 82.

Loc. "Generally distributed."]

[112. DENDROCYGNA VAGANS, *Eyton*; *Salvad. op. cit.* ix. p. 49; *Gray, Hand-l. B.* iii. p. 79.

Loc. "Water-holes near Laroki River, &c.]

113. D. GUTTATA (*Forsten*); *Salvad. & D'Albert. t. c.* p. 839; *Salvad. t. c.* p. 49.—D. guttulata, *Ramsay, t. c.* p. 395.

Loc. "In water-holes and creeks at the back of the coast-range."

114. TADORNA RADJAH, *Garn.*; *Sharpe*, anteà, p. 321; *Ramsay, t. c.* p. 395.

Loc. Laroki River.

Fam. LARIDÆ.

[115. STERNA MELANAUCHEN, *Temm.*; *Saunders, P. Z. S.* 1876, p. 661.

Loc. Port Moresby.]

Fam. PELECANIDÆ.

[116. PHALACROCORAX LEUCOGASTER, *Gould*; *Gray, Hand-l. B.* iii. p. 128.

Loc. Port Moresby.]

On Species of Crustacea living within the Venus's Flower-basket (*Euplectella*) and in *Meyerina claviformis*. By EDWARD J. MIERS, F.L.S., F.Z.S., Assistant in the Zoological Department, British Museum.

[Read June 7, 1877.]

(Plate XXIV.)

WITH the late Dr. Bowerbank's collection of Sponges recently purchased by the Trustees of the British Museum, a bottle was received containing Crustacea preserved in spirit and labelled as follows:—"Crustacea from within *Alcyoncellum speciosum*, off Zebu, Philippine Islands, 95 fathoms, from 'Challenger.'" These specimens were in excellent condition, and, upon examination, proved to belong to two species, one belonging to the *Peneidæ*, the other being an Isopod of the genus *Æga*.

The existence of Crustacea within the cavities of the beautiful and well-known Vitreous Sponges, which have been variously described under the generic names of *Alcyoncellum* and *Euplectella*, has long been known to naturalists. De Haan, in his account of the Crustacea in the 'Fauna Japonica' of v. Siebold (p. 194, pl. xlvi. fig. 9), describes and figures a new genus and species of the family *Peneidæ*, to which he assigns the name *Spongicola venusta*, and habitat "in *Alcyoncellis*," without definite locality, and which is characterized by the non-palpigerous outer maxillipeds, and the very great development of the third pair of legs, which is analogous to the enlargement of the second pair in many genera of *Palæmonidæ*. Dr. J. E. Gray (Ann. & Mag. Nat. Hist. xviii. p. 489, 1866) briefly notices the occurrence of "a crab" in the *Euplectella speciosa*, which is regarded by the Spaniards in Manilla as formed by the animal for its protection, observing that the animal must take its place in the tube before the network at the upper end is formed, as when that part is added it becomes imprisoned. In a further notice of the same species of sponge in the following year (Ann. & Mag. Nat. Hist. xix. p. 44, 1867), he quotes the opinion of the fishermen of Zebu, and of M. Trimoulet, fils, of Bordeaux, that the sponge is the nest of the crustacean that inhabits it, which, in the case of the specimens examined by M. Trimoulet, belonged to the "section des *Isopodes nageurs*."

Dr. Semper, 'Archiv f. Naturgeschichte,' 1867, p. 84, in an interesting memoir "On *Euplectella aspergillum*, Owen, and its Inhabitants" (translated in Ann. & Mag. Nat. Hist. ii. p. 26, 1868),

after justly repudiating the theories of the Spanish fishermen and French naturalist regarding the origin of the sponge, describes the Isopod from specimens in his collection under the name of *Æga spongiophila*, stating that it is always associated with a pretty species of *Palæmonidæ*, which, on account of the damaged condition of the specimens, he was unable to determine generically, but which I have little doubt is the *Spongicola venusta* of De Haan. This *Æga spongiophila*, although the description leaves some important particulars unnoticed, agrees, as far as it goes, with the specimens from Zebu recently acquired by the Trustees. Mr. T. J. Moore (Ann. & Mag. Nat. Hist. iii. p. 196, 1869) gives, upon the authority of Captain Robert Morgan, Zebu as the true habitat of *Euplectella aspergillum*, and appends a rough sketch by Capt. Morgan of the sponge *in situ* and its inhabitant (by which latter is presumably intended the *Spongicola venusta*); but the figure is evidently a mere sketch from memory. Finally, the late Dr. R. v. Willemöes Suhm, in his fifth letter to Prof. C. v. Siebold on the results of the 'Challenger' Expedition (Zeitsch. f. wiss. Zool. xxvi. Append. p. lxxiv, 1876), mentions that, of the parasites of the *Euplectella*, the *Æga spongiophila* occurs most commonly, next to it the *Palæmon* (probably the *Spongicola venusta*), whose zoëa he was able to hatch, also a white *Aphrodita*, and, lastly, in less abundance, a small *Pecten*.

Dr. Semper, in the paper above referred to, announced his intention of shortly publishing more accurate descriptions of the Crustacea observed by him, accompanied by figures, but does not appear ever to have carried his purpose into effect. I have therefore thought it desirable to append to this notice full descriptions and accurate illustrations of the specimens I have before me, by which the question of their identity with the *Spongicola venusta* and *Æga spongiophila* may be determined with certainty.

SPONGICOLA VENUSTA, *De Haan, Crust. in Fauna Japonica*, p. 194, pl. xlvi. fig. 9 (1850), ♂. Pl. XXIV. figs. 1 & 2.

Body nearly smooth. Rostrum trigonous, about reaching to the apex of the peduncle of the antennules, with eight to ten small teeth on its upper margin, and one on the lower margin near the apex. One or two of the teeth of the upper margin are posterior to the anterior margin of the cephalothorax. On the dorsal surface of the cephalothorax, a short distance behind the origin of the rostrum, are two small spines.

On the anterior margin of the carapace, between the points of insertion of the eye-peduncles and antennæ, is a small spine, posterior to this upon the hepatic region a second spine, and beneath the hepatic spine, upon the antennal region, a series of 2–4 spines in an oblique series. The posterior margin of the cephalothorax is deeply sinuated above; the terminal half of the postabdomen is inflexed and usually more or less adpressed to the ventral surface of the body. The first segment of the postabdomen is the shortest; the lateral lobes of the second to sixth segments are triangular and acute in the male, broader and more rounded in the female; the terminal segment is elongate-oval, ciliated on the posterior margin, with two longitudinal keels, each of which is trispinose, on the upper surface, and with three spines on the lateral margins. The eyes are short and subcylindrical. The antennules are about as long as the cephalothorax, the two flagella of equal length. The peduncles of the antennæ are short, not half as long as the outer scale; the flagella broken, but evidently much longer than those of the antennules, and thickly clothed with long hairs; the outer lamina with the outer margin straight, denticulated in its distal half, the inner margin strongly arcuate and ciliated. The outer maxillipeds are slender, with long hairs on their inner margins, the joints diminishing successively in length. The first and second pairs of legs are very slender; the chelæ shorter and no thicker than the wrists, those of the second pair longer than the first; third pair very much enlarged, the arm thickening to the distal extremity, near which is a small spine on the superior and exterior margins; the wrist very small, with a blunt subapical lobe on its upper and lower surface: the hand ovate, slightly granulated and hairy on its outer and inner surface, much larger at base than the wrist; the superior and inferior margins thin, but scarcely carinated, and ciliated, the superior margin armed with serrated teeth; the fingers compressed, serrated on their outer margins, meeting along their inner edges when closed, acute at the apices, a blunt tooth on their inner margins. Fourth and fifth pairs of legs slender and slightly hairy; claws bispinose. Rami of the appendages of the postabdominal segments ovate and ciliated; those of the penultimate segment serrated on their outer margins and with long hairs on the posterior margins; the inner ramus longitudinally unicostate, the outer subtruncate at the extremity and longitudinally bicostate. Length to end of rostrum about 1 inch 2 lines.

Two specimens are in the Collection—one is a female with ova, the other I believe to be a male.

In De Haan's description of *Spongicola venusta* no mention is made of the two spines on the dorsal surface of the cephalothorax, behind the rostrum (which in his specimens is 9-toothed), nor of the serrate teeth on the upper margin of the hand and on the appendages of the sixth postabdominal segment, although there are indications of these in his figure of the species in the case of the last-mentioned organs. The hand in the figure is represented as longer in proportion to its depth. The description, however, coincides in all essential particulars with the specimens from Zebu; and the habitat "in *Alcyoncellis*" being the same, I have little doubt that the species are identical.

ÆGA SPONGIOPHILA, *Semper*, *Archiv f. Naturg.* xxxi. p. 84 (1867); *Ann. & Mag. Nat. Hist.* (ser. 4) vol. ii. p. 26 (1868). Pl. XXIV. figs. 3–5.

The body is elongate-oval, moderately convex and punctulated; the punctures nowhere very crowded, but most numerous upon the head and first segment of the body. The head is transverse, about twice as broad at base as it is long, with a small median triangular frontal lobe, that is produced between the basal joints of the upper antennæ. The first segment of the body is rather the longest; the lateral margins of all the segments form nearly a right angle with the posterior margins, the postero-lateral angles of the segments being themselves somewhat rounded. Six segments of the postabdomen are exposed; the first five are very short, acute, and slightly produced backward at the lateral angles; the terminal segment is longer than the five preceding taken together, but not quite as long as broad at the base, flat above, with a shallow indentation parallel to its basal margin, semioval, with ciliated margins. The eyes are black, broad at base, where they cover a part of the inflexed lateral margins of the head; seen from above, they are pyriform in shape, narrowing to the distal extremity, which recedes slightly from the anterior margin of the head. The upper antennæ are short, when retracted not reaching to the posterior margin of the first segment of the body: three joints of the peduncle are visible; the first much enlarged, with a shallow indentation on its upper surface, perhaps indicating the coalescence of two joints; the third joint is about twice as long as and narrower than the second. The inferior antennæ are very long, when retracted reaching beyond the posterior margin of the sixth segment of the

body; their bases are concealed by a narrow process of the epistoma: five joints of the peduncle are visible; of these, the first and second are very short, the third rather longer, the fourth as long as the three preceding, the fifth as long as the fourth. The first three pairs of legs are short and prehensile; the coxæ of the second and third pairs oblong, rounded at their postero-lateral angles, and marked with two oblique impressed lines; the femora not dilated; the succeeding joints short, naked; the dactyli strong, arcuate, and acute. The fourth to seventh pairs of legs are slender and gressorial; the coxæ are acute at the postero-lateral angles, those of the fifth to seventh pair greatly produced backward; the femora are slender, elongate, not dilated, but slightly keeled on their posterior margins; the succeeding joints slender, with a few stiff hairs at their distal extremities and along their anterior margins. The foliated appendages of the first five postabdominal segments are not ciliated on the margins; the rami of the appendages of the sixth segment are broad and semitransparent, truncated at the distal extremities, obscurely serrated and ciliated on the posterior and exterior margins, and do not quite reach to the end of the terminal segment; the inner triangular; the outer irregularly quadrilateral, with the inner margin straight and parallel to the distal half of the outer margin. Colour yellowish white, with minute brownish-pink spots, which are visible only upon the head and first two segments of the body. Length 1 inch $7\frac{1}{2}$ lines.

Of this species an adult female, from which the above description is taken, a smaller individual (length 1 inch 2 lines), and four young, the smallest scarcely exceeding 7 lines, are in the collection. The length of the antennæ and form of the terminal segment and of the serrated uropoda suffice to distinguish this species from its congeners.

Nearly all the specimens of *Euplectella* in the Collection of the British Museum contain Crustacea which appear to belong to one or other of the species above described, but cannot be determined with certainty without extraction from the sponges—an operation which could not be effected without injury to the specimens.

In another fine species of Sponge from Zebu (the *Meyerina claviformis*, described by the late Dr. J. E. Gray from specimens brought home by Dr. A. B. Meyer) are several specimens of an Isopod Crustacean quite distinct from the foregoing species. An example of this Sponge having been divided longitudinally for the purpose of showing its interior structure, I have been enabled to examine and identify these Isopoda with a species

noticed but not described by A. White, in the 'List of Crustacea in the British Museum,' p. 107, 1847, under the name of *Æga hirta*, and subsequently described as *Æ. multidigita* by Dana, in his account of the Crustacea collected in the U.S. Exploring Expedition under Commodore Wilkes.

CIROLANA MULTIDIGITATA.—Æga hirta, *White, List Crust. Brit. Mus.* p. 107 (1847), sine descr.—Æ. multidigita, *Dana, U.S. Expl. Exp.* xiii., *Crust.* i. p. 768, pl. li. fig. 3 (1853). Pl. XXIV. figs. 6–11.

Body oblong-elliptical, moderately convex; all the segments hispid, with short hairs, which are longest on the posterior margins of the segments, and denser on the postabdominal segments. The head is transverse, with a small, acute, median frontal lobe. The first segment of the body is rather the longest, and its anterior margin is closely applied to the base of the head; the postero-lateral margins of all the segments are broadly rounded. Five segments of the postabdomen are exposed; the first four are very short; the lateral angles of the second segment are acute, of the third obtuse and round; the terminal segment is triangular, usually about as long as broad (but in the specimen bearing White's MS. name rather broader than long), subacute at the apical extremity. The eyes, viewed from above, are suboblong, and extend along half the lateral margins of the head. The upper antennæ are short, reaching little beyond the posterior margin of the head; peduncle two-jointed, the basal joint but little enlarged, the second joint scarcely thicker than the flagellum. Lower antennæ more than half as long as the body, and separated at base by a very narrow process of the epistome; peduncle five-jointed, the first three joints very short, the fourth and fifth long, slender, and subequal; flagellum naked. The coxæ of all the legs are obliquely carinated; those of the first to third pairs rounded at the postero-lateral angles; of the fourth to seventh pairs with the postero-lateral angles acute, and of the sixth and seventh pairs greatly produced backward; the basal joints of all the legs are but slightly dilated, those of the last four pairs slightly keeled on their posterior margins; the third to sixth joints of all the legs armed with short spines on their under surface; the dactyli of all the legs are short, arcuate, and acute. The rami of the appendages of the penultimate postabdominal segment are very unequal; the outer very narrow and shorter than the inner, which is triangular, broadest and truncate at its distal extremity; the margins are not serrated; they do not reach to the apex of the terminal segment. Length nearly 1 inch.

Hab. Philippine Islands. (Several specimens, adult and young, within *Meyerina claviformis*, Gray, from Zebu.)

If the position of the animals in the Sponge be natural and undisturbed, they would seem to have made their way to the hollow interior by breaking through the tissues. Several specimens are actually embedded in the substance of the Sponge. One which I extracted is an adult female with ova; another is quite young.

On account of the non-dilatation of the basal joints of the antennules, and the long inferior antennæ, &c., this species appears to be better placed in the genus *Cirolana* than in *Æga*. It is at once distinguishable by the triangular terminal segment, the spines on the under surface of the legs, and the form of the rami of the sixth pair of postabdominal appendages. The specimen bearing White's MS. name is from Swan River. Dana's specimens are from Borneo; and his figure agrees in every respect with the specimens from the Philippines, except that the inner ramus of the uropoda is represented as less distinctly triangular and truncated at the extremity. The *Æga macronema* of Bleeker (Acta Soc. Sci. Indo-Neerl. ii. p. 23, pl. i. fig. 1, 1857), taken from various species of fish inhabiting the seas of Batavia, has, like this species, a triangular terminal segment, but differs in the form of the uropoda, &c.

In the British Museum are several specimens from the Philippines, presented by S. T. Martin, Esq., "from the interior of *Meyerina*," and others "from Sponges collected by Dr. Meyer." In what appear to be the males, the median frontal lobe is greatly produced, reflexed, and blunt at the extremity. In some specimens the body is nearly or quite destitute of hair.

DESCRIPTION OF PLATE XXIV.

Fig. 1. *Spongicola venusta*, De Haan. Lateral view of ♀, × twice nat. size.
2. —— ——. Dorsal view of its cephalothorax.
3. *Æga spongiophila*, Semper. Lateral view of ♀, nat. size.
4. —— ——. Dorsal aspect of ♀, nat. size.
5. —— ——. Front foreshortened view of head, antennules, and antennæ, × twice nat. size.
6, 7, 8. *Cirolana multidigitata*, Dana, shown in three different positions within the sponge-tissue of *Meyerina claviformis*, Gray; drawn from mounted specimen in British Museum. Fig. 6 is a sketch of a median longitudinal section of the sponge, displaying (*a*) the animal in the central excretory canal: *os*, oscular area; others close by are partially covered by the spicular veil. In fig. 7 an animal (*a*) fills an oscular space; and in fig. 9 an exterior view of same is shown, a dermal lacework of spicules surrounding. All nat size.
9. Head of male *C. multidigitata*, × twice nat. size.
10. Ditto of female *C. multidigitata*, × twice nat. size.
11. Upper view of terminal segment and uropoda of same species, nat. size.

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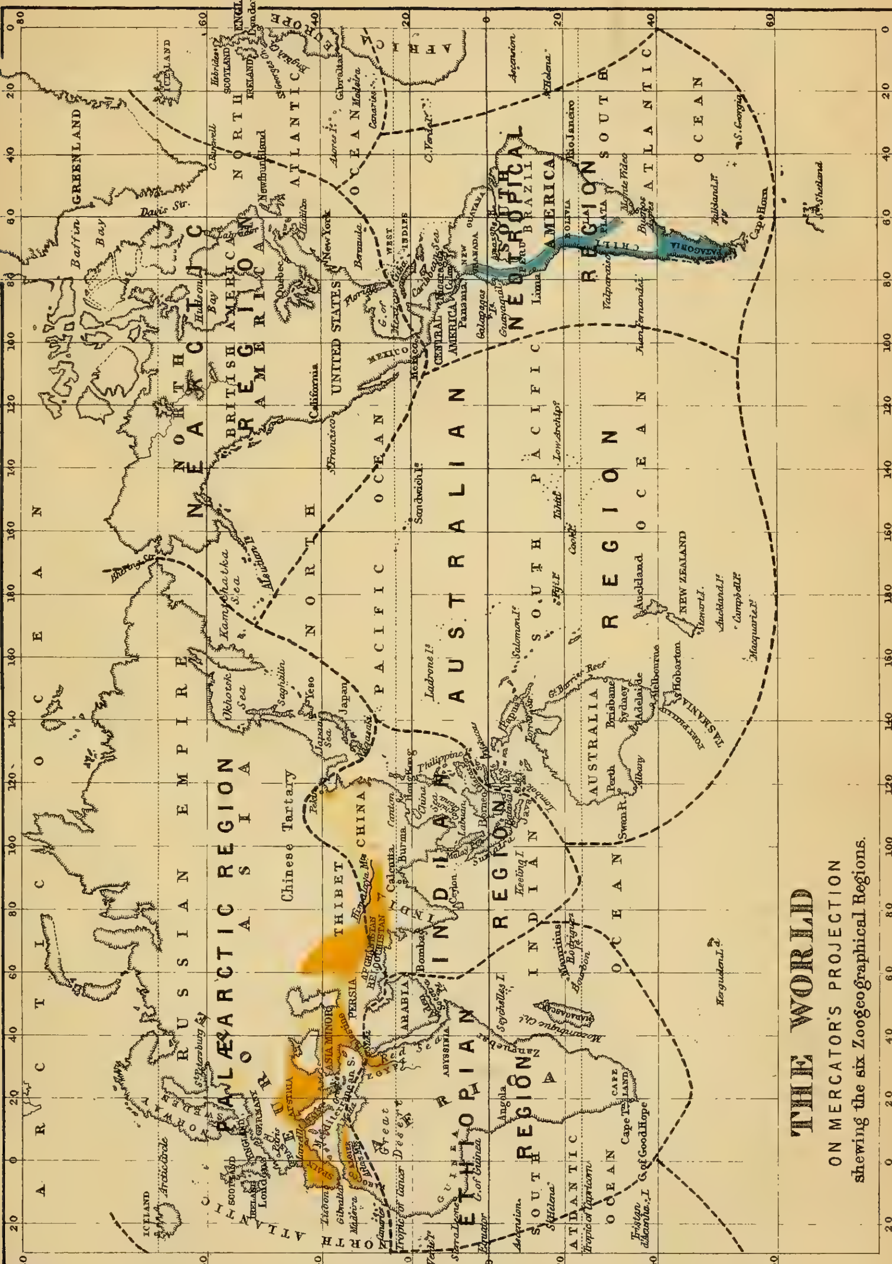

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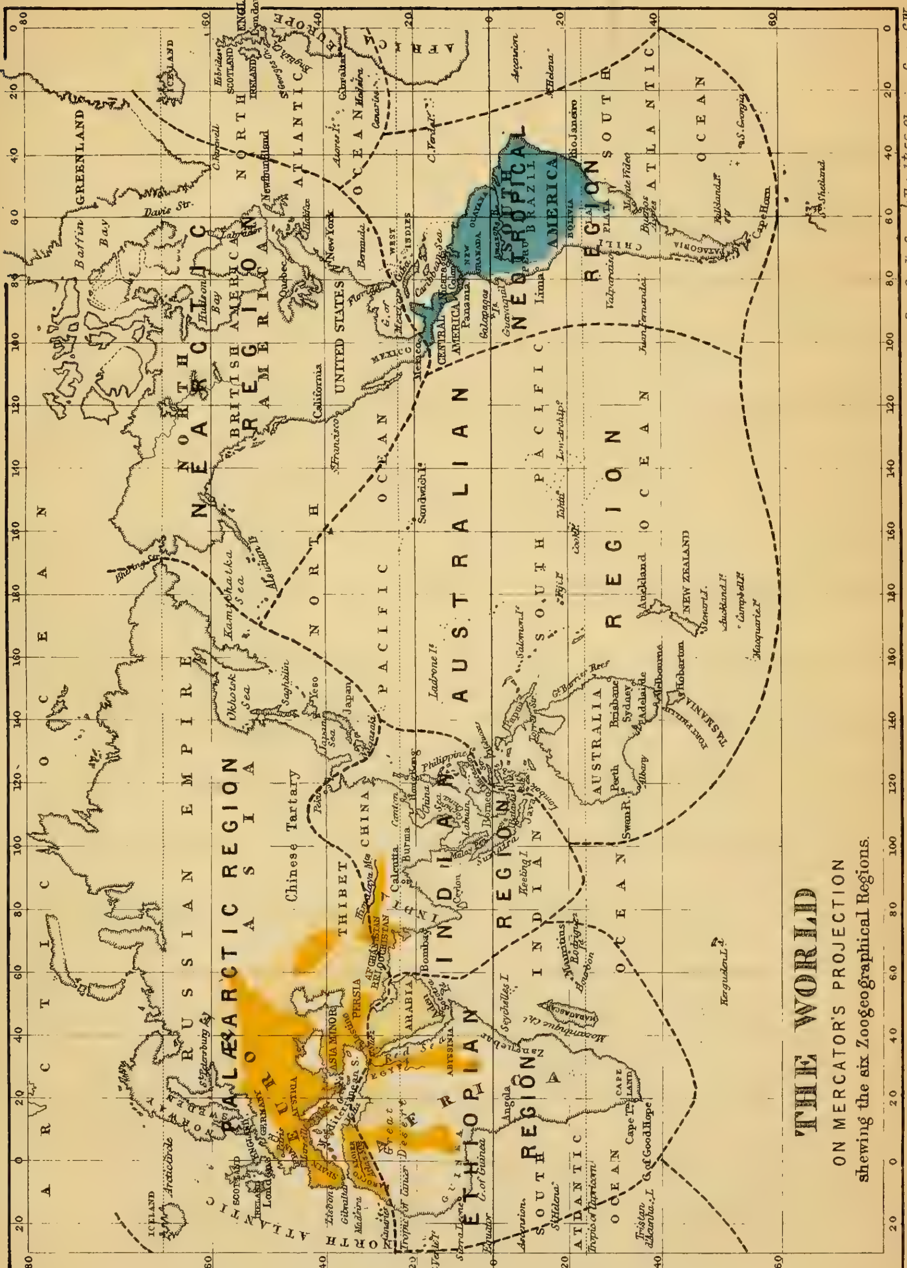

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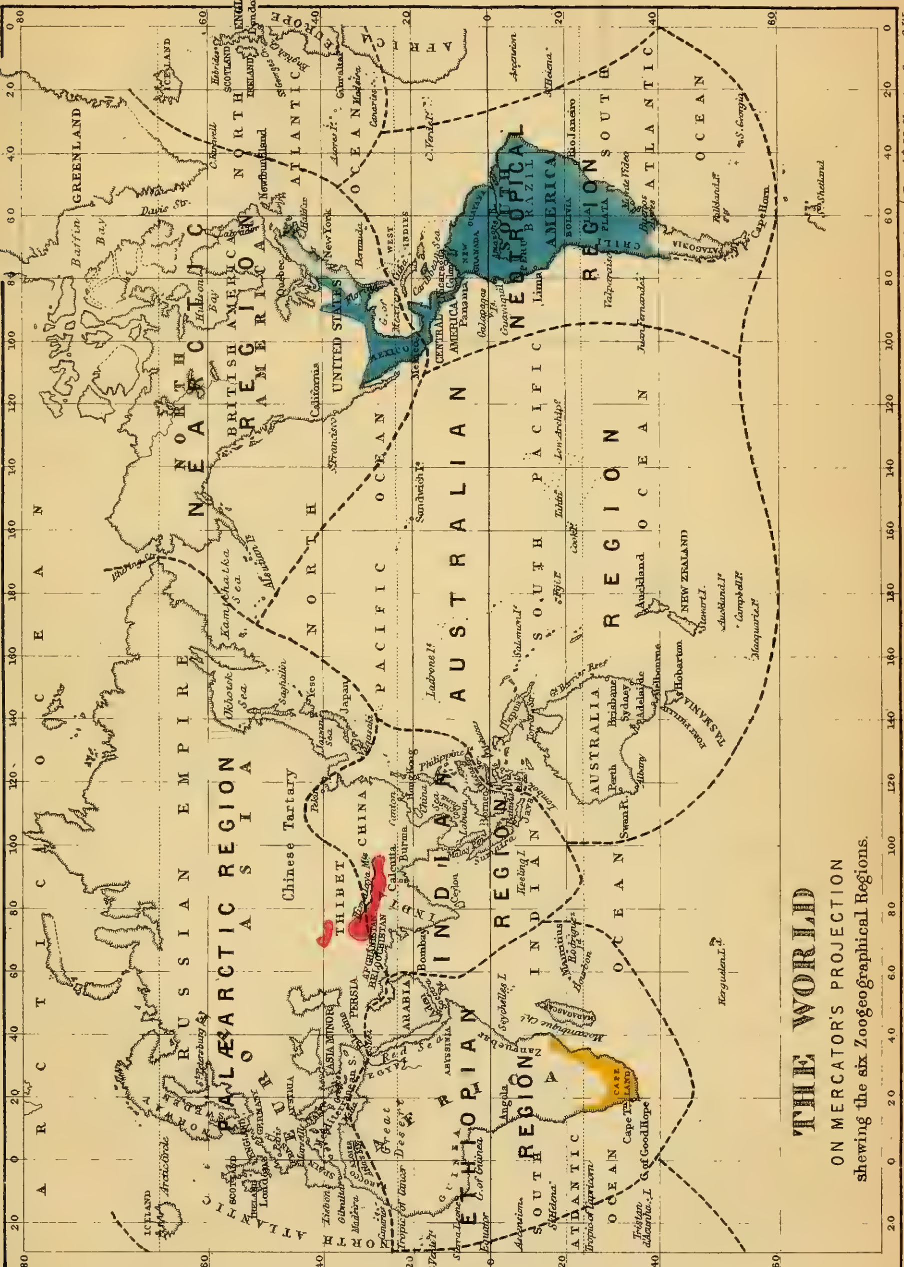

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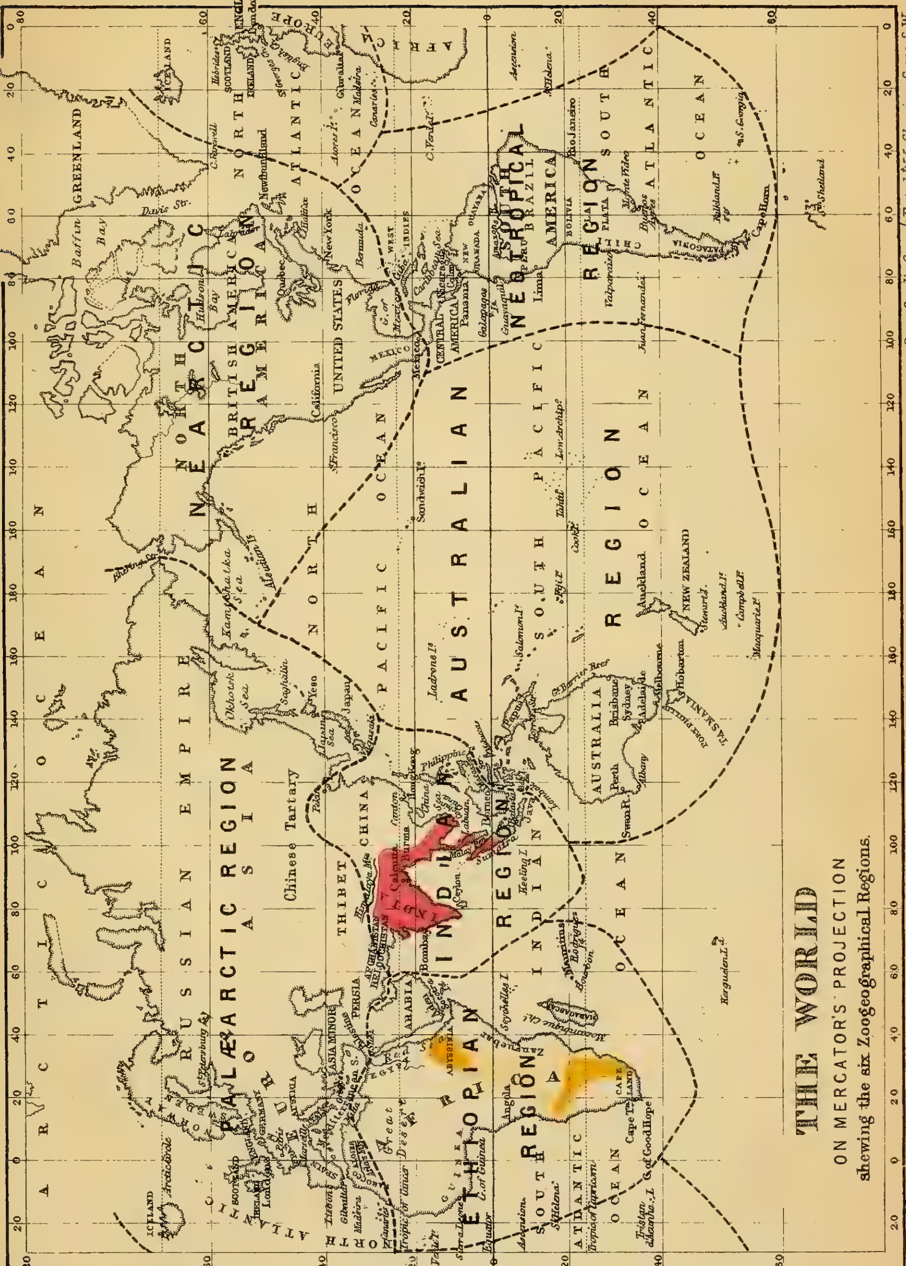

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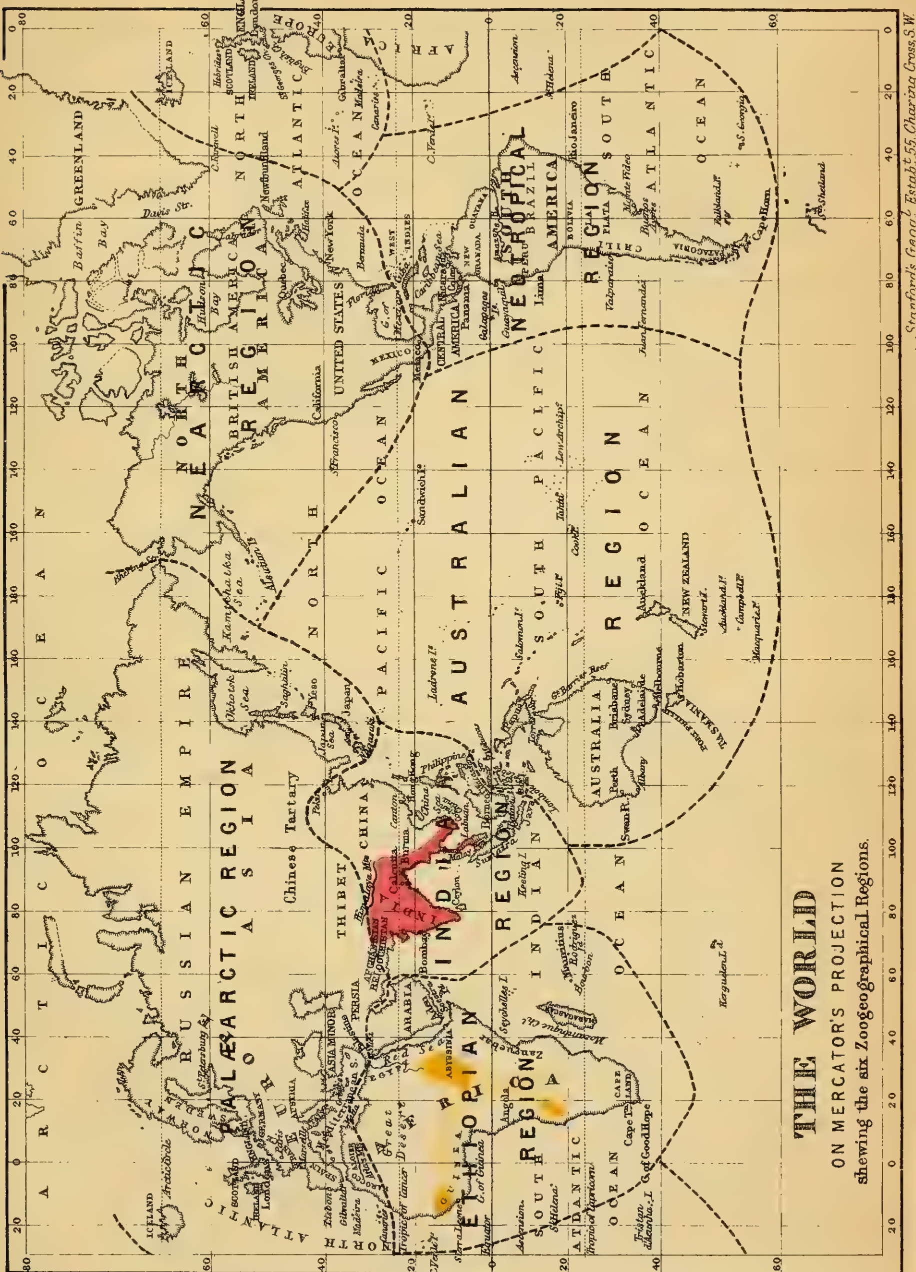

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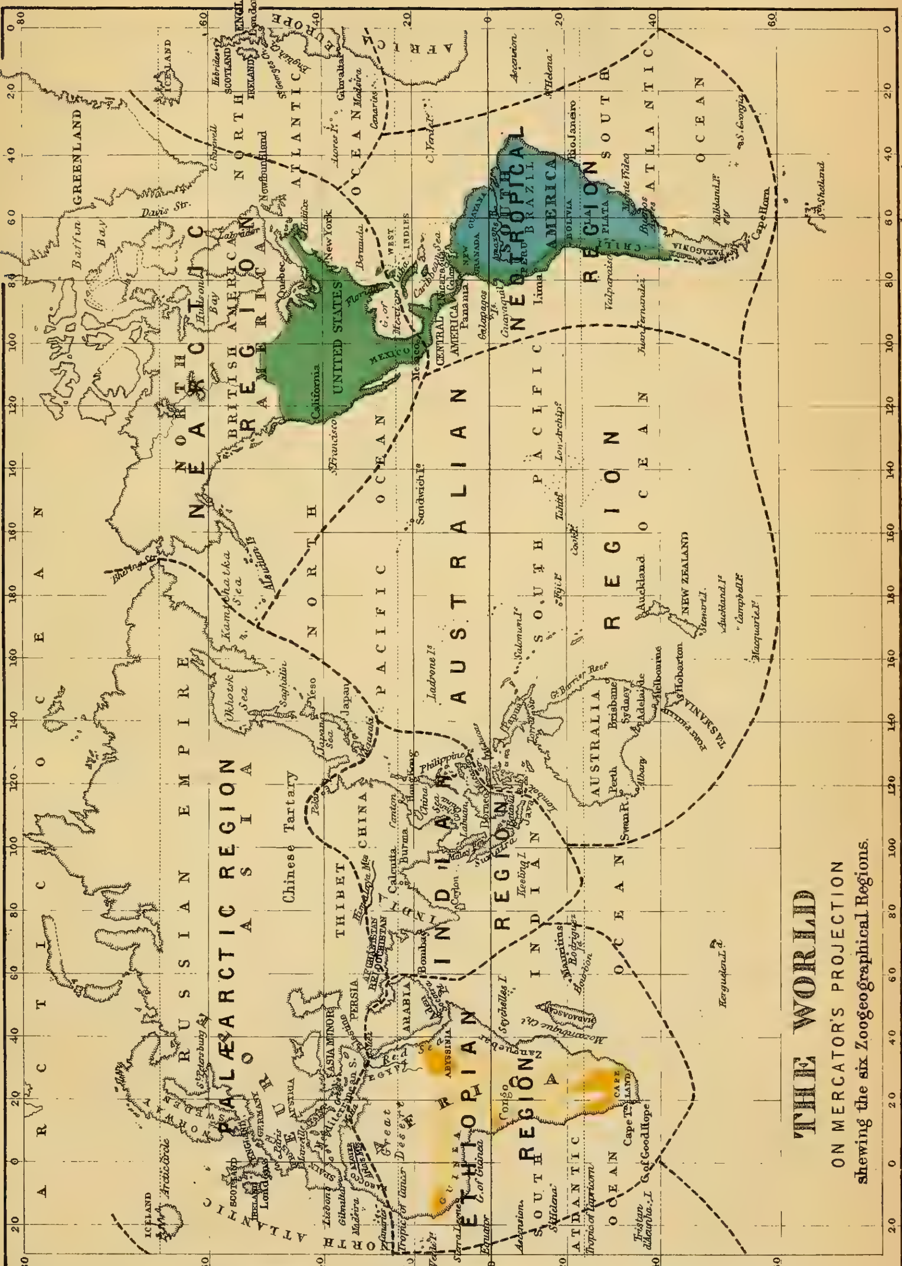

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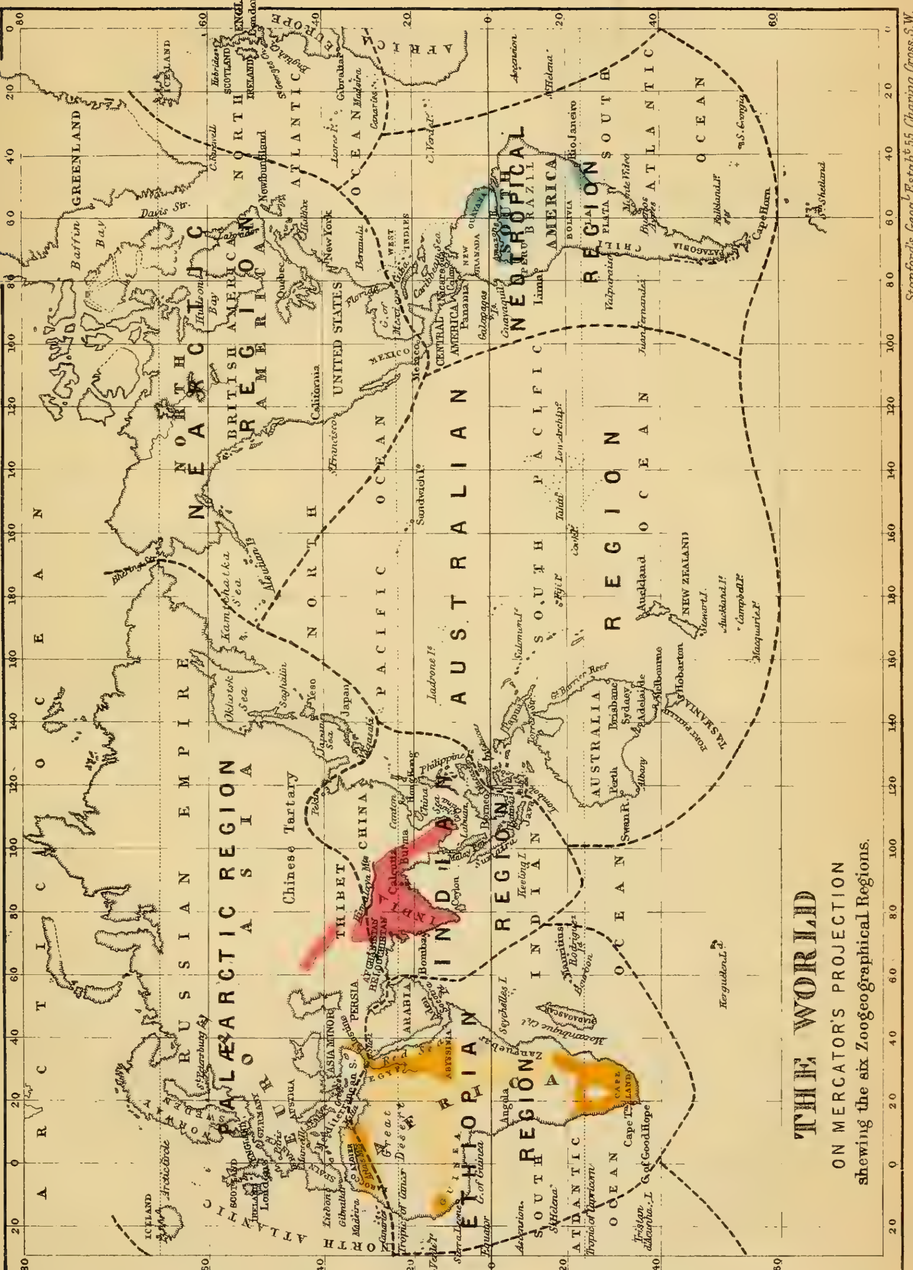

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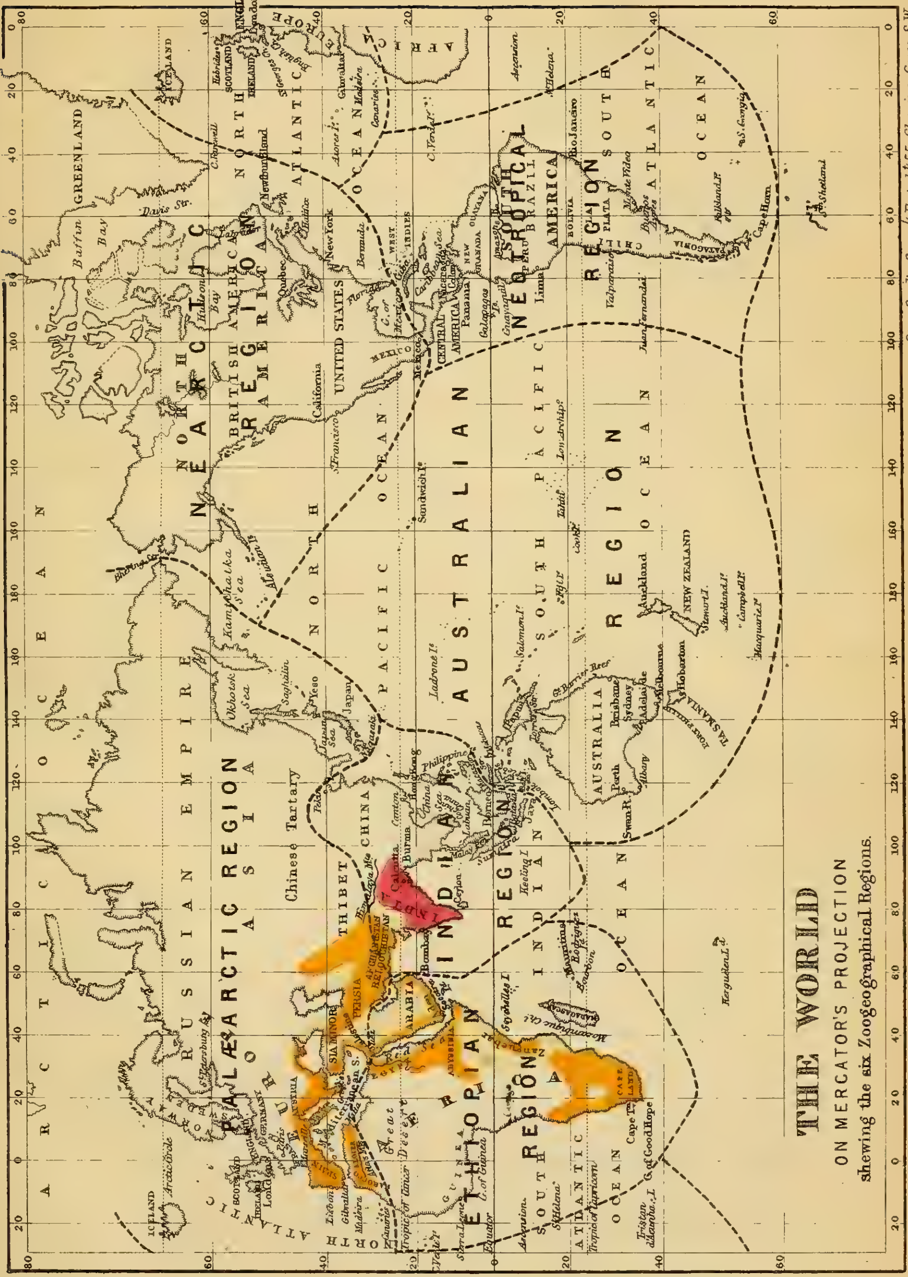

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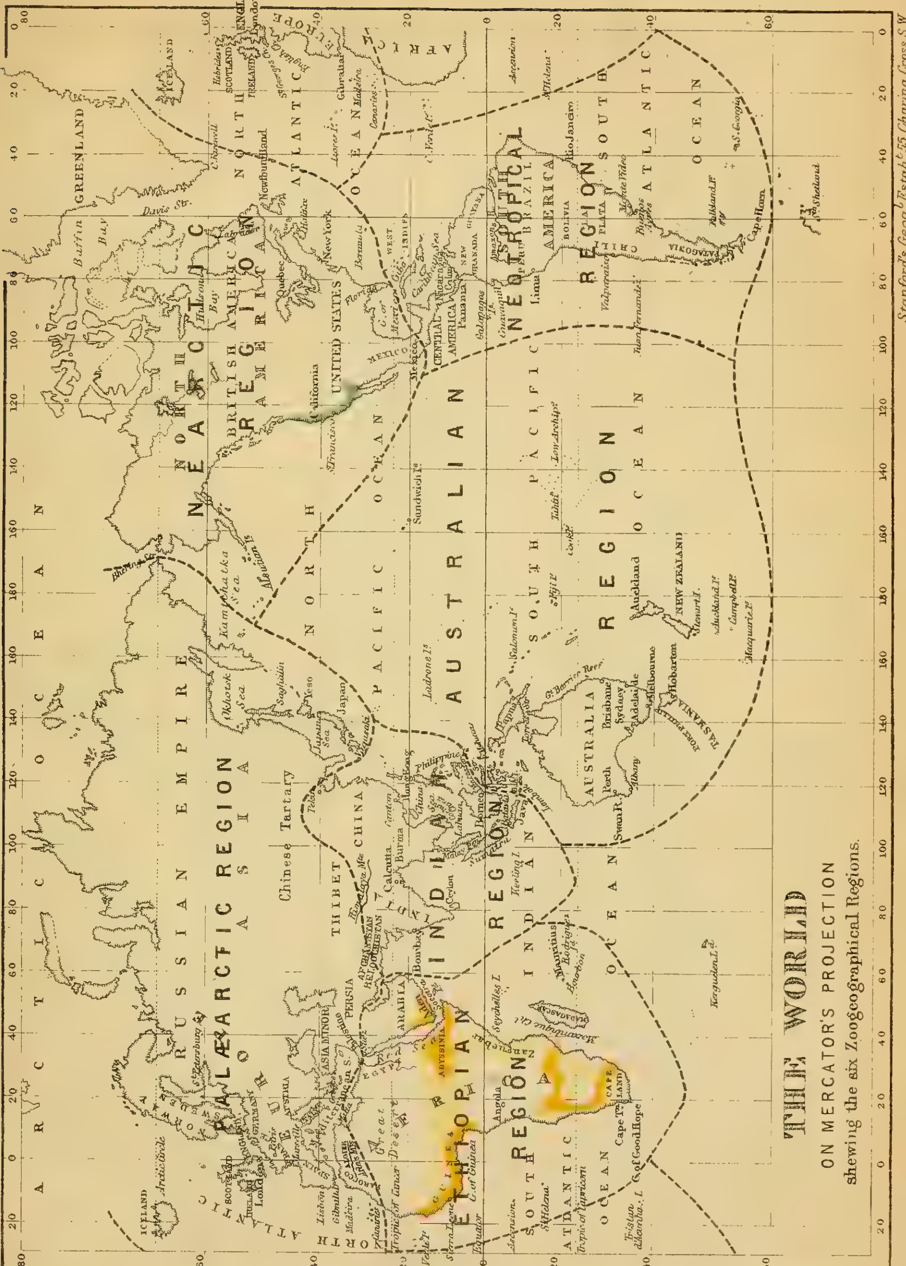

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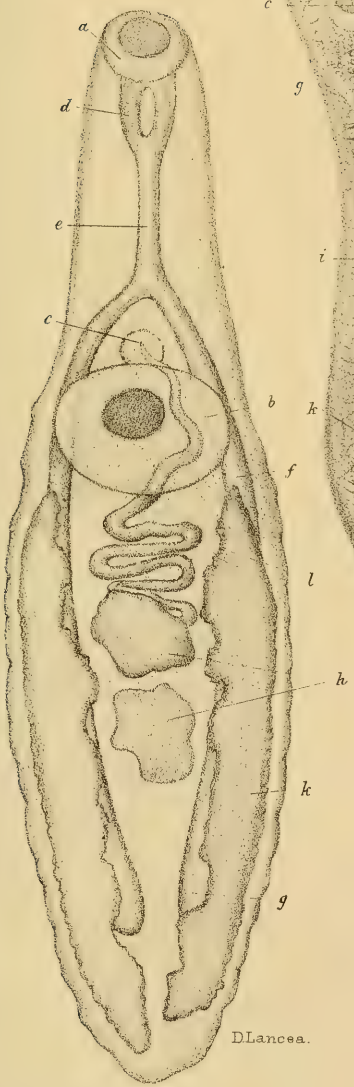


D. Lancea.

Fig. 3.

D. Andersoni.

Fig. 2.

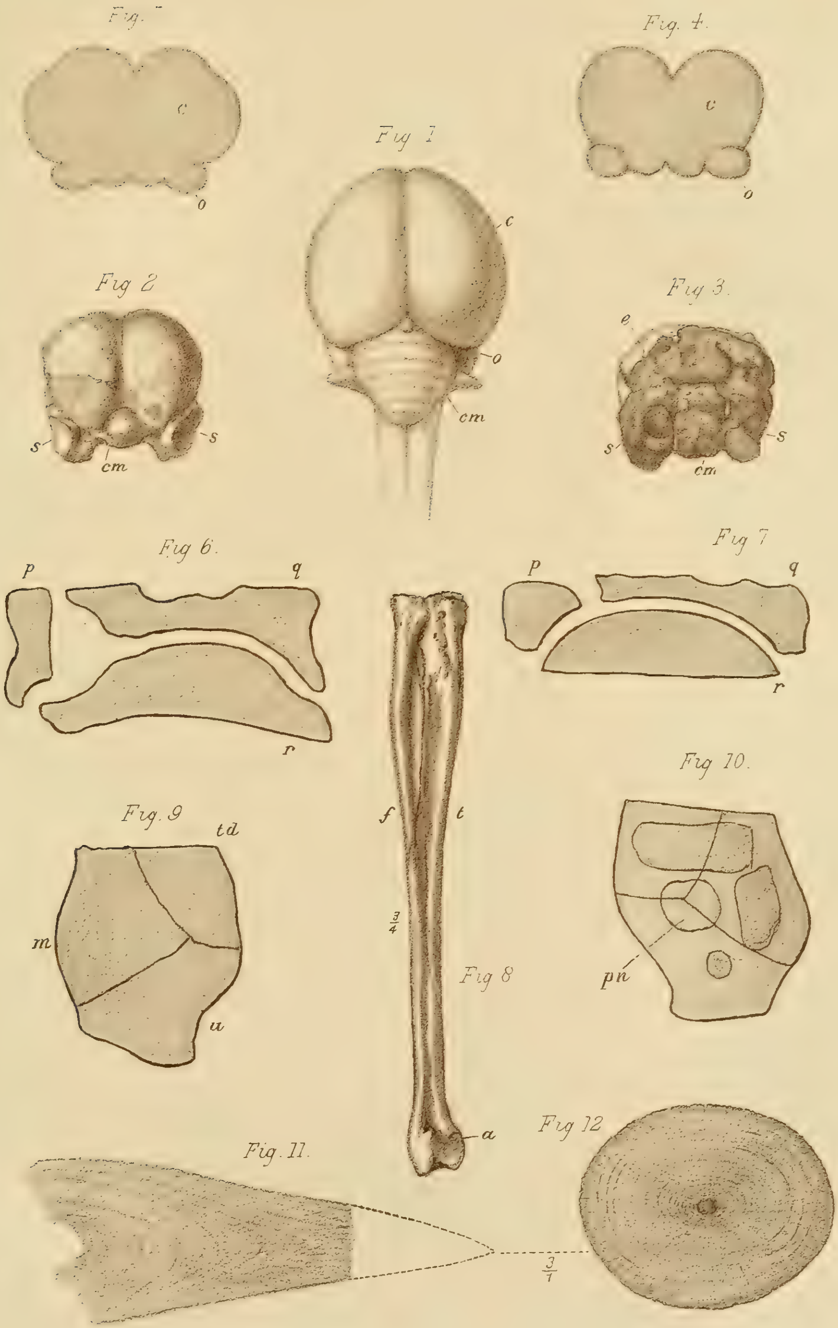
D. Campula.

Berjeau lith.

Hanhart imp.

FLUKES.

FROM GANGETIC DOLPHINS.



Berjeau lith.

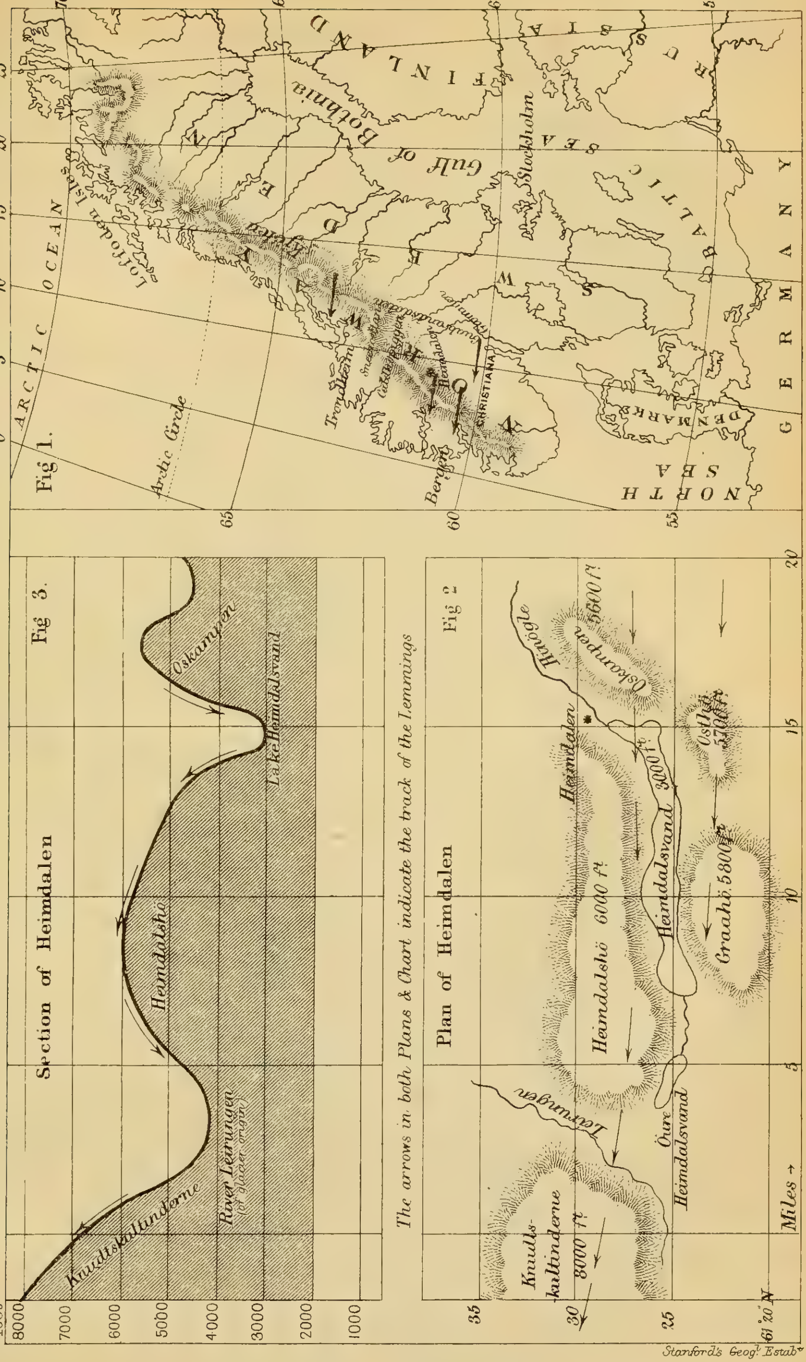
Hanhart imp.

ORNITHOSAURIA &c.

Berjeau lith.

Hanhart imp.

NEW SPECIES OF EUPTYCHIA.



Stanford's Geog^l Estab^t

MIGRATION OF LEMMINGS.

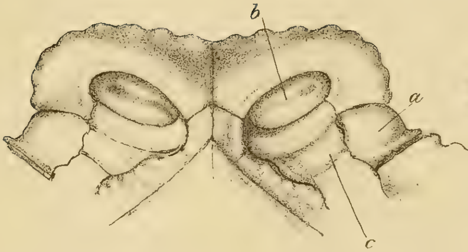
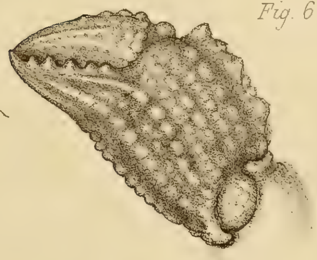


Fig 4

Fig. 6



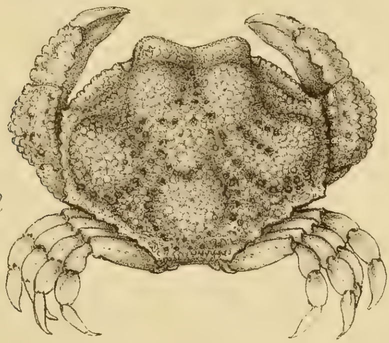
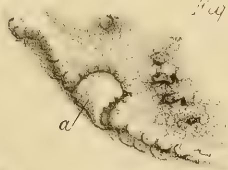


Fig 2

Fig 5



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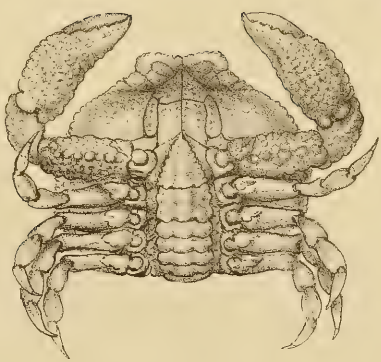
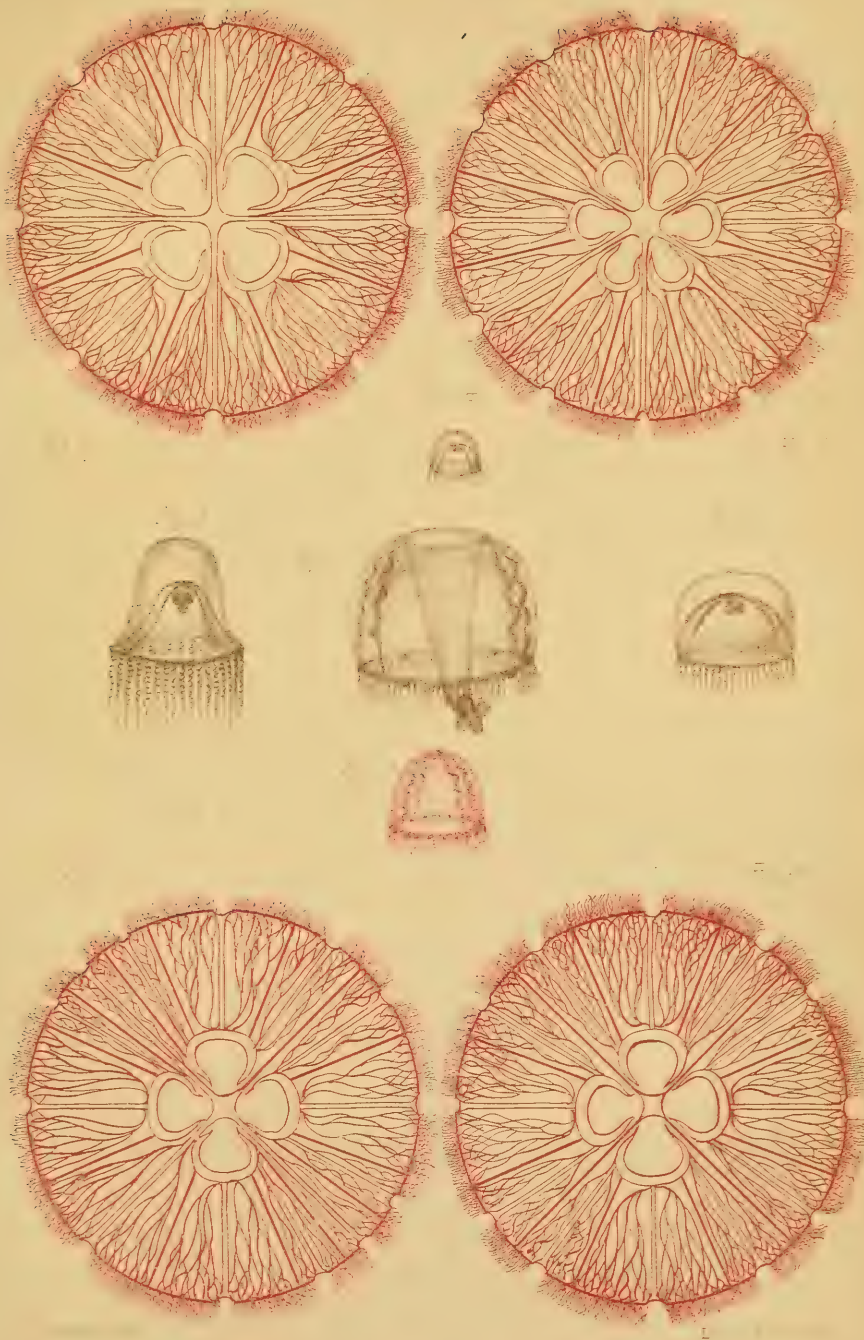


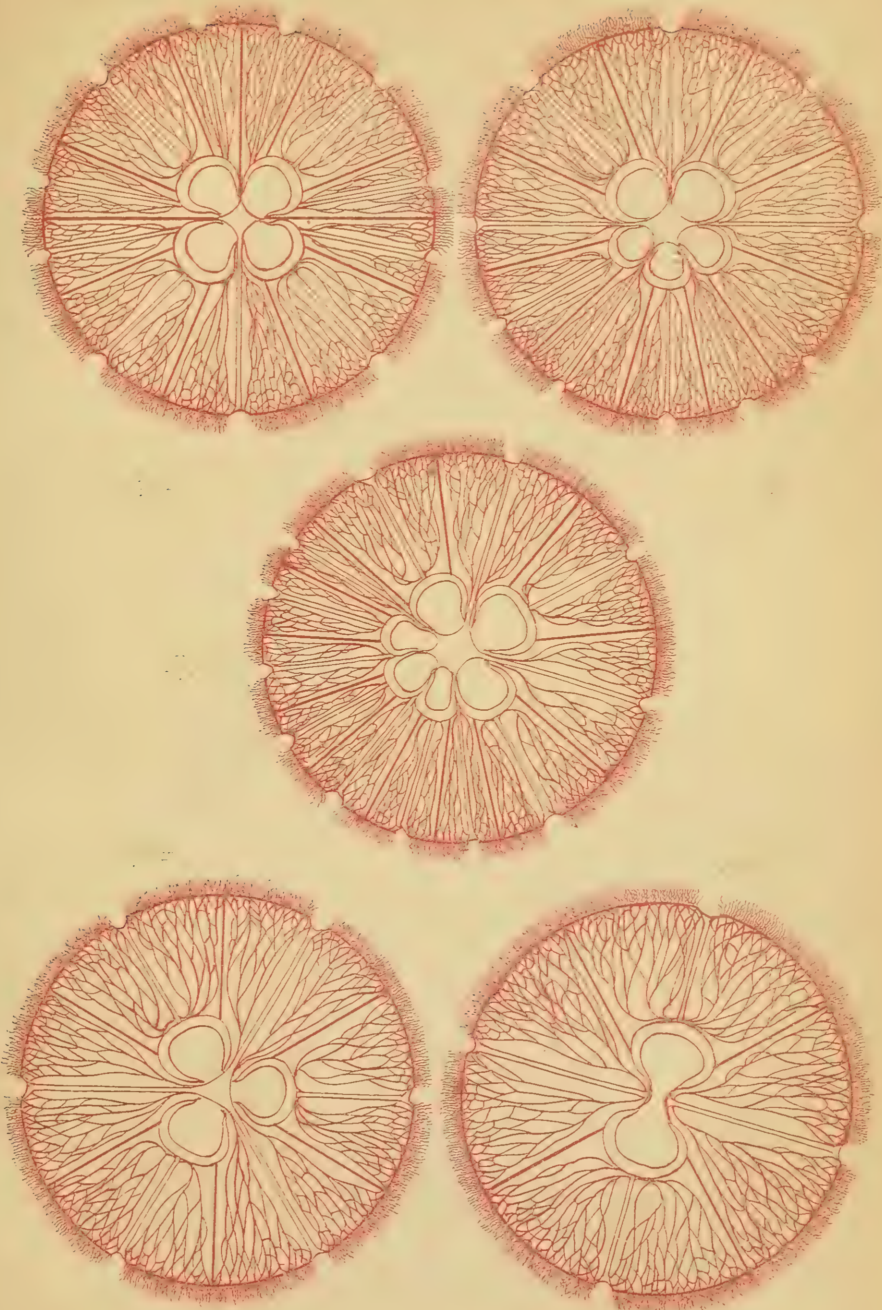
Fig 3

Berjeau lith.

Hanhart imp

ACTÆOMORPHA EROSA.





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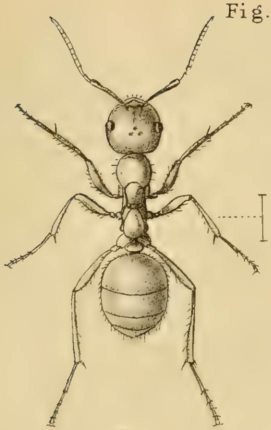
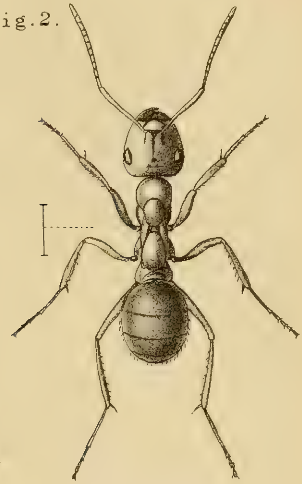


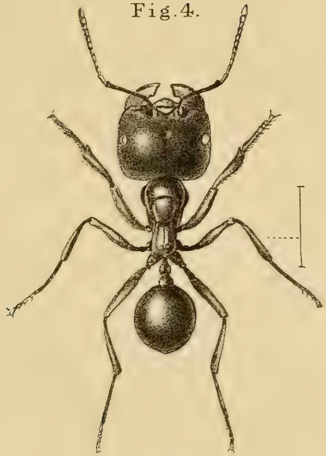
Polyergus rufescens

Fig. 2.



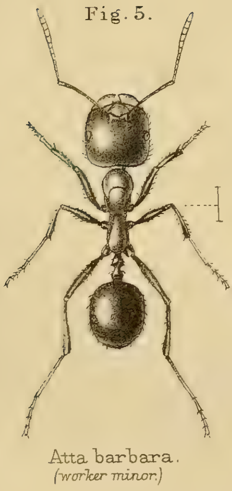
Formica sanguinea.

Fig. 4.



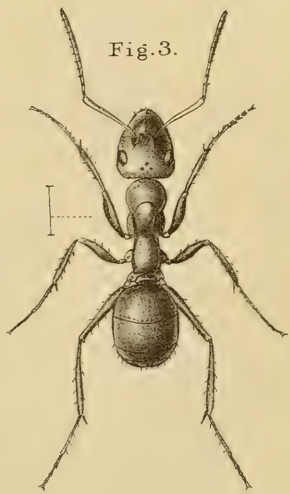
Atta barbara.
(worker major.)

Fig. 5.



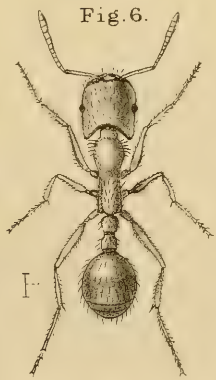
Atta barbara.
(worker minor.)

Fig. 3.



Formica fusca.

Fig. 6.



Strongylognathus testaceus.

E. A. Smith. Mintern Bros. imp.

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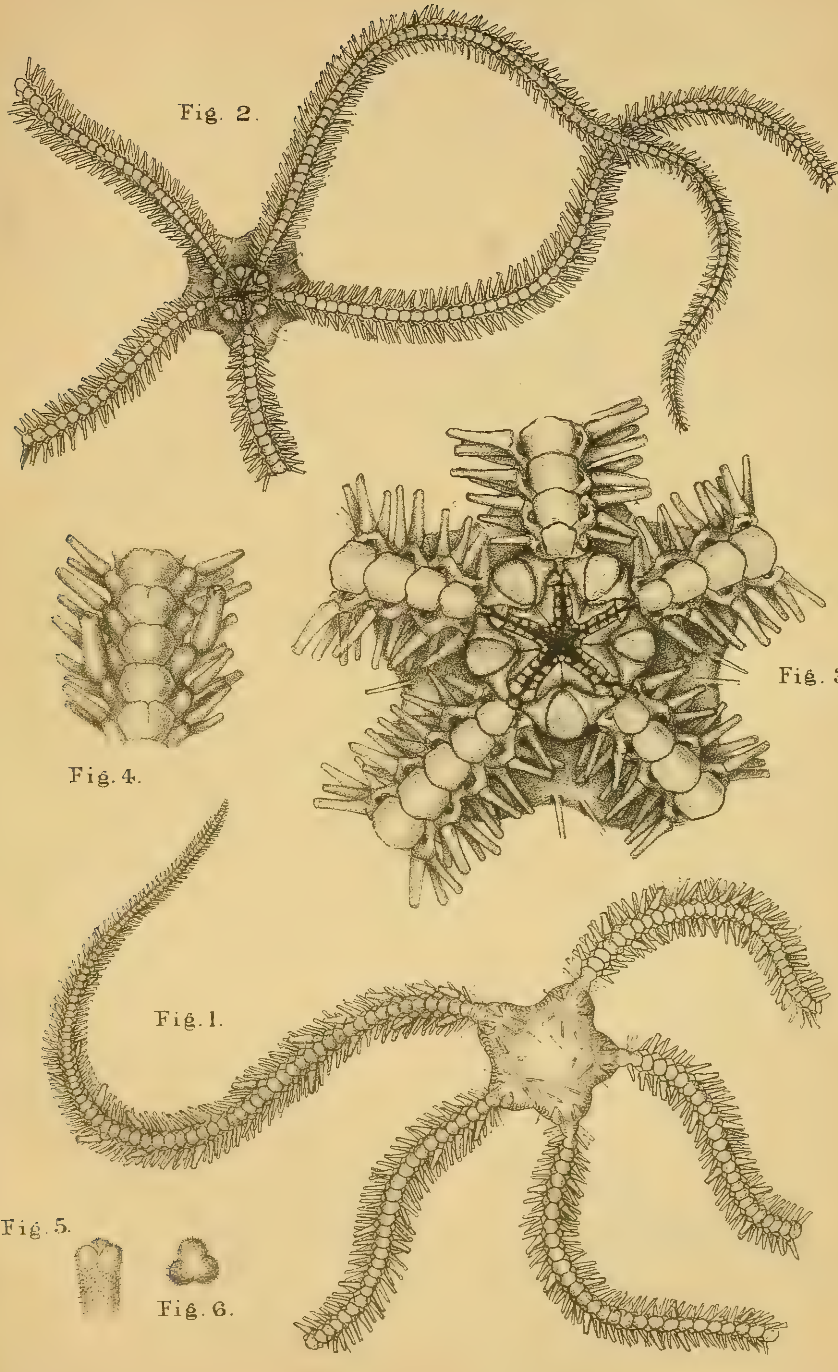
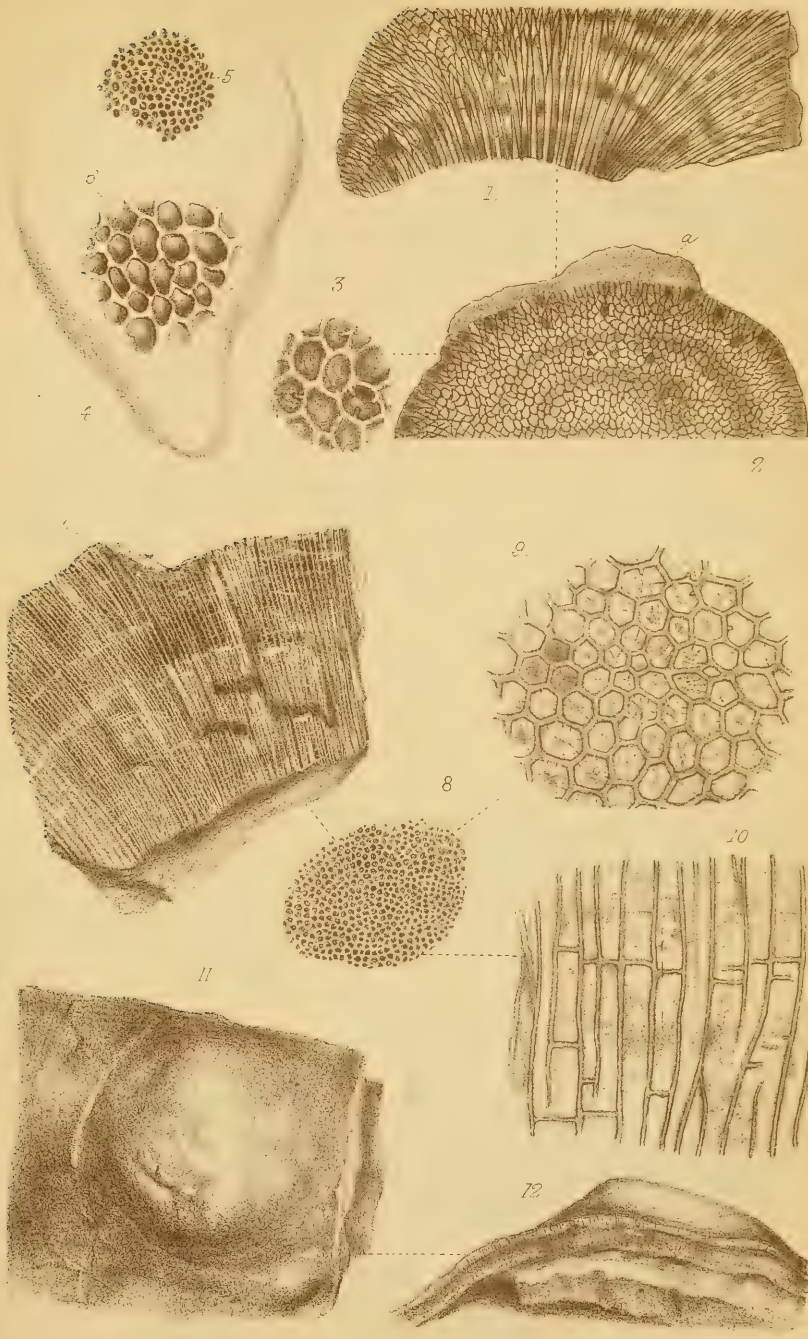


Berjeau lith.

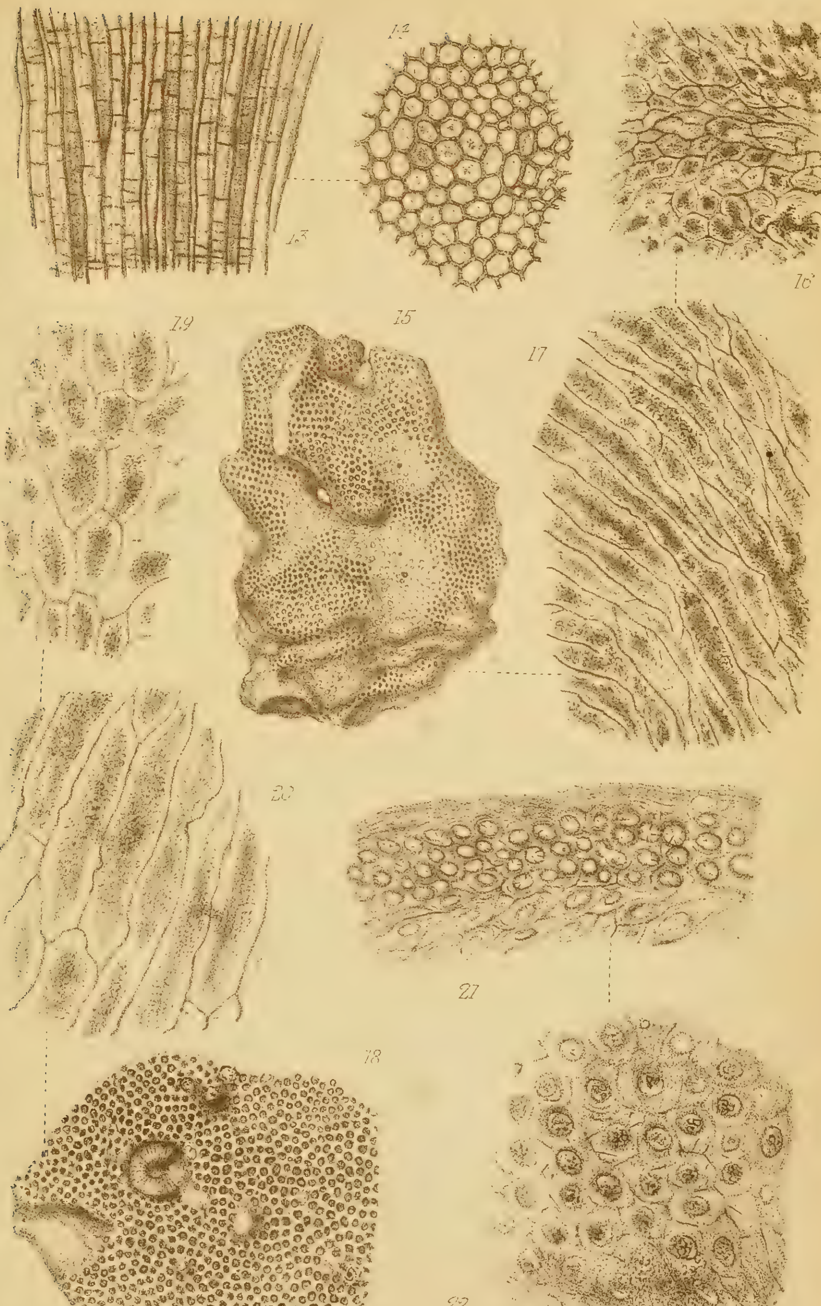
Mintern Bros imp.

ACANTHARACHNA MIRABILIS



. Berjeau. Lith.

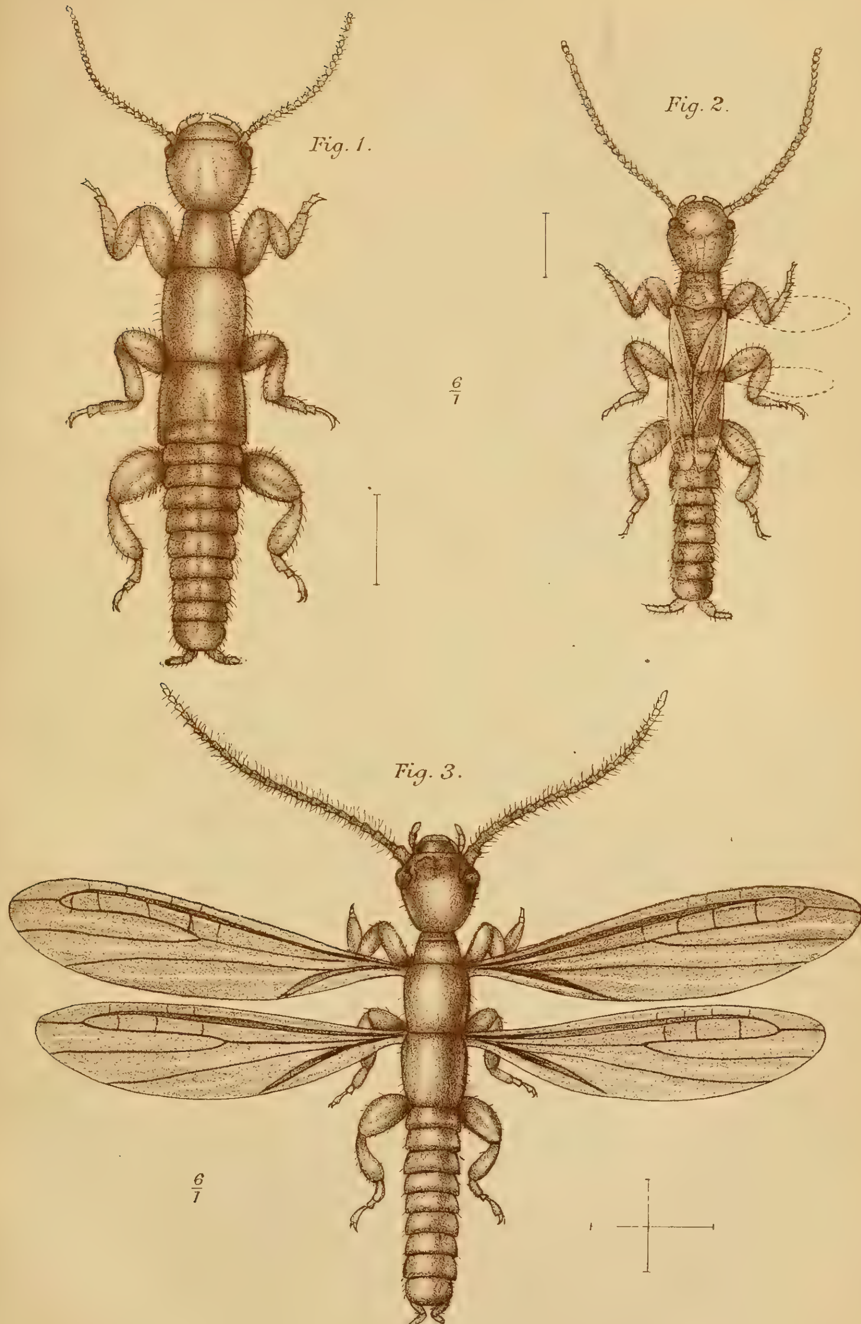
PALÆOZOIC CORALS



C. Berjeau, Lith.

Banks & Co. Edinr.

PALÆOZOIC CORALS



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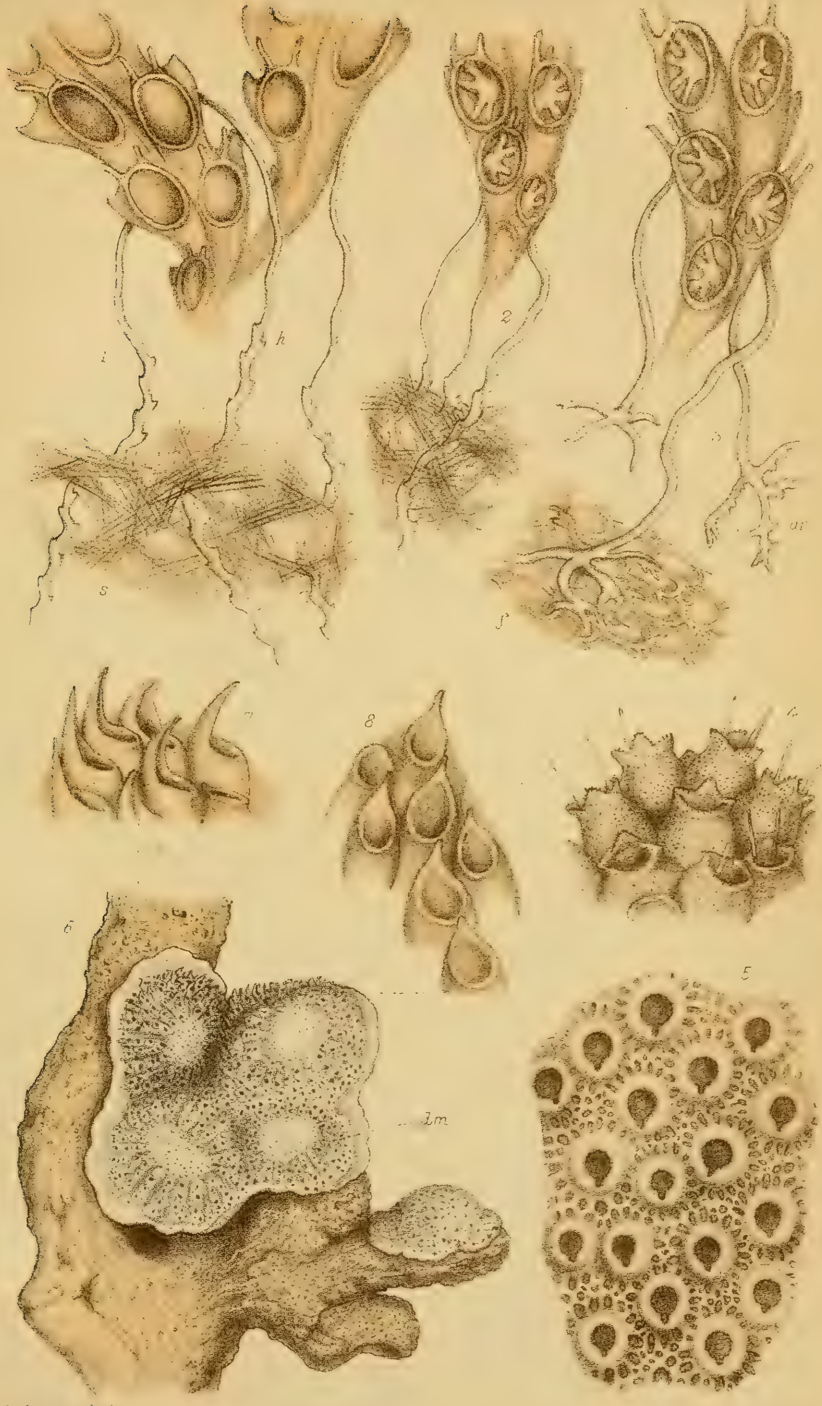
OLIGOTOMA MICHÆLI.

Keulemans lith. ASTUR MEYERIANUS. Hanhart imp



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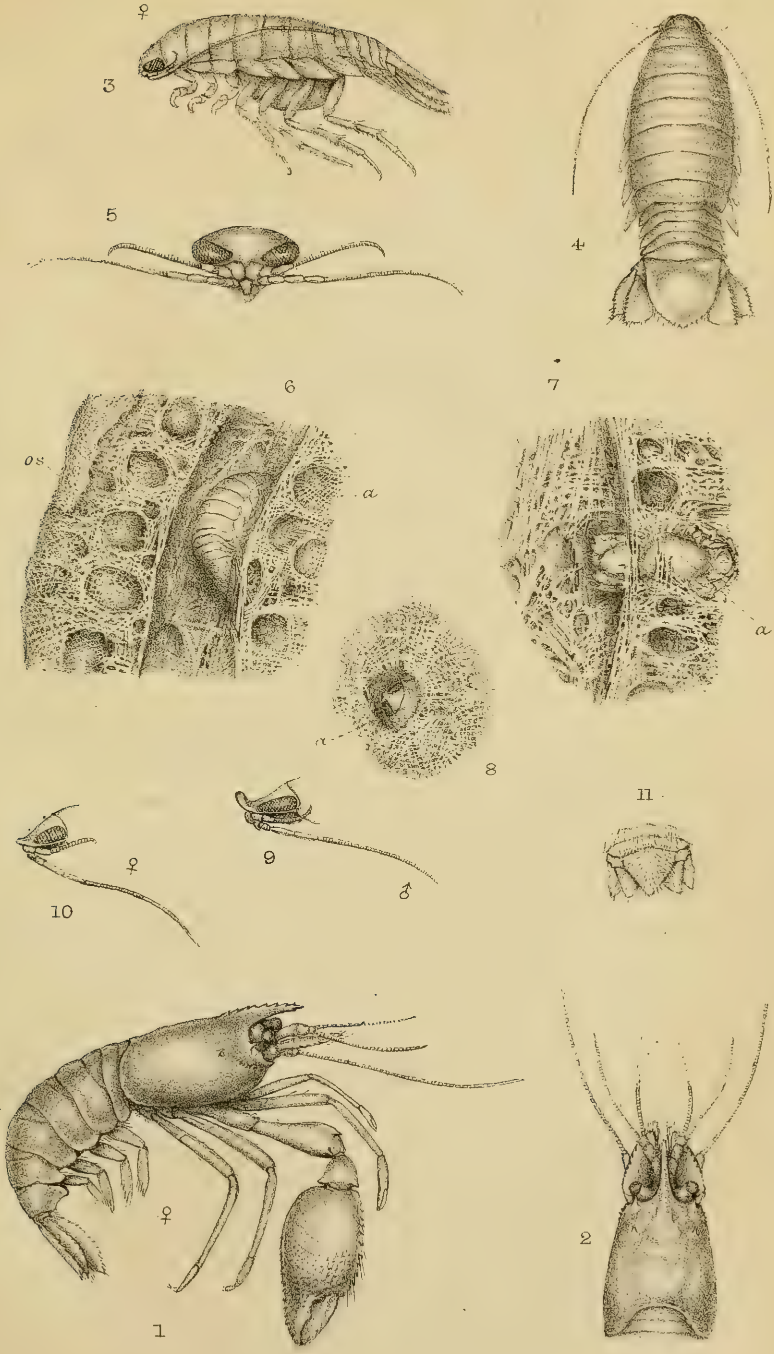

Berjeau lith. W. West & Co. imp.

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DECEMBER 15. *Price 2s.*

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OF

THE LINNEAN SOCIETY.

VOL. XIII. ZOOLOGY. No. 66.

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1876.

NOTICE.

Henceforward the Zoological and Botanical portions of the Journal will be published separately.

Each volume will consist of Eight numbers, instead of Four.

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Vol. XIII. **ZOOLOGY.** No. 67.

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VOL. XIII. **ZOOLOGY.** No. 68.

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